VOLUME NO. 2

EXPLANATORY NOTES

FOR

DEPARTMENT OF AGRICULTURE

BUDGET ESTIMATES

FISCAL YEAR

1943

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VOLUME NO. 2

EXPLANATORY NOTES

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(Volume 2)

BUREAU OF DAIRY INDUSTRY

(a) SALARIES AND EXPENSES

The Budget estimate proposes consolidation of the two appropriation items in order to simplify accounting and other operations. Since the bureau has only the one appropriation, namely "Dairy investigations" for its subject matter work and the entire staff, including those paid from the appropriation entitled "General administrative expenses" is engaged in work toward the overall objectives of the bureau, increased efficiency should result from the proposed consolidation.

Appropriation Act, 1942:	
General administrative expenses	$75,400
Dairy investigations	655,905
Supplemental for within-grade promotions	7,172
Total appropriations, 1942	738,477
Budget estimate, 1943	764,757
Change from 1942:	
Net increase in working funds	+20,695
Additional for administrative promotions	+ 5,585
Net increase	+26,280

PROJECT STATEMENT

Projects	1941	1942 (estimated)	1943 (estimated)	Increase or decrease
1. Investigations of milk and butterfat production of dairy cows	$476,363	$460,045	$482,240	+ $22,195 (1)
2. Market-milk investigations..	28,405	32,070	32,070	- -
3. Investigations of the utilization of milk in the manufacture of milk products	146,221	163,790	163,790	- -
4. General administration and business service	75,256	75,400	73,900	- 1,500 (2)
5. Net cost of within-grade promotions	- -	7,172	12,757	+ 5,585
Unobligated balance	5,060	- -	- -	- -
Total	731,305	738,477	764,757	+ 26,280

INCREASES OR DECREASES

The increase in working funds of $20,695 in this item for 1943 consists of:

(1) A net increase of $22,195 in Project 1, as follows:

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The increase in working funds of $20,695 in this item for 1943 consists of:

(1) A net increase of $22,195 in Project 1, as follows:

(a) An increase of $2,300 for maintenance of the Beltsville Dairy Experiment Station, to meet the increased costs of operating and maintaining buildings and equipment at the Beltsville Research Center.

In recent years the Beltsville, Md., dairy station has been faced with the necessity of meeting increasingly heavy maintenance and operating costs. Since 1934, 31 buildings and equipment valued at approximately $360,000 have been added to the dairy unit, without any provision having been made for their maintenance and operation. The older buildings and equipment are constantly in need of repairs to make them usable. Under present conditions it is possible to meet only emergency needs. It is not possible with available funds to maintain a program designed to prevent deterioration of the buildings and equipment and to avoid costly future repairs. Of the total station allotment, only $7,700 is available for repairs to buildings and equipment. This amount is not adequate for a program designed to prevent costly deterioration of the buildings and equipment.

(b) Am increase of $40,320 for the genetic analysis of animals in dairy-herd-improvement associations.

Objective: To maintain the dairy-herd-improvement association program of identification of dairy animals and the permanent recording of production records on a satisfactory basis in order that dairymen may be provided data essential to the adoption of an intelligent program for the improvement of their herds. During the past three years the work of the project was maintained on a current basis through W.P.A. assistance. Such assistance was withdrawn on July 1, 1941, and as a result the analysis and tabulation of material has been retarded and reports are rapidly accumulating. Unless the data and reports received from the States are promptly tabulated dairymen cannot be furnished current information necessary to guide them in their herd-improvement programs.

The problem and its significance: There are approximately 26,000,000 cows in the United States kept for milking purposes. These cows have an average production of approximately 181 pounds of butterfat per year and return approximately $40 above feed cost. This production and return are much too low to pay, in most cases, for general and overhead expenses and allow the dairyman anything whatever for his labor. The problem, therefore, is to raise the average production to the point where it will not only pay for feed and overhead but will also return a profit to the farmer. That this is possible is demonstrated by the fact that the 676,000 cows on test in 1,300 dairy-herd-improvement associations in 1940 had an average butterfat production of 331 pounds per year and returned approximately $95 above feed cost. Approximately 31,000 dairymen who are members of dairy-herd-improvement associations voluntarily pay a total of more than $1,250,000 each year to support their local associations. In return for this large annual expenditure they receive information which enables them to improve the producing efficiency of their dairy herds. Association members have improved their herds until the average yearly butterfat production of association cows is approximately 30 pounds more than it was 10 to 15 years ago. This increased producing efficiency is resulting in a total increased income to association members of approximately $8,000,000 a year. It is the purpose of this project to identify dairy sires in dairy-herd-improvement association

herds which are proved to possess the ability to transmit inheritance for high levels of production to their offspring in order that their influence may be perpetuated and disseminated throughout the dairy-cow population. Through such a program the production of all cows may eventually be more efficient and profitable.

As dairymen recognize the merits of this nation-wide improvement program the number of dairy-herd-improvement associations and the number of cows on test have materially increased.

Plan of work: The identification and production records obtained on the 763,000 cows in dairy-herd-improvement associations are reported by the associations through the various State agricultural colleges. These data are compiled to show the breeding value of individual animals and families of animals, and are furnished the State Extension Services for use in conducting constructive dairy cattle breeding programs.

(c) A decrease of $20,000 for dairy cattle breeding, feeding, and management investigations, which contemplates (a) discontinuance of the dairy work at Jeanerette, La., ($10,415) and (b) curtailment of work at other field experiment stations ($9,585).

(d) A general reduction of $425 which represents an anticipated economy resulting from the proposed consolidation of the two appropriation items.

(2) A decrease of $1,500 for general administrative and business service, due to the elimination of the position of assistant architect.

CHANGE IN LANGUAGE

The estimates include a proposed change in language as follows (new language underscored, deleted matter enclosed in brackets):

> [Dairy investigations] Salaries and expenses: For [conducting] necessary expenses, including not to exceed $397,400 for personal services in the District of Columbia, of the Bureau of Dairy Industry in carrying out the provisions of the Act of May 29, 1924 (7 U.S.C. 401-404) including investigations, experiments, and demonstrations in dairy industry, cooperative investigations of the dairy industry in the various States, [and] inspection of renovated-butter factories, [including] repairs to buildings, and not to exceed $5,000 for the construction of buildings.

This change is for the purpose of consolidating the items of "General administrative expenses", and "Dairy investigations", as previously explained, and does not change existing authority.

WORK UNDER THIS APPROPRIATION

Objective: To increase the milk and butterfat producing efficiency of the nation's dairy cows; to improve the quality of products made from milk; to effect greater efficiency in manufacturing methods; to develop new

products which may increase the markets for milk and provide for the more efficient utilization of milk byproducts; to investigate the sanitary production, transportation, processing, and distribution of market milk and cream, and to enforce the renovated butter act.

The problem and its significance: There are about 26 million cows in the United States kept for milking purposes. The average butterfat production of these cows is 181 pounds a year. Only one-third of these cows are actually returning a profit to their owners. Methods of selecting and breeding should be devised whereby 90 percent or more of the animals raised for dairy purposes would possess an inheritance for profitable production when properly fed and managed.

The national dairy herd must be fed in a manner which will insure that the health of the animals will be maintained, that the milk and butterfat produced will contain a maximum of nutritive and health-giving properties, and that the herd will produce profitably. Research is also directed toward finding more economical methods of feeding for milk production, in order to demonstrate that, although some methods of feeding actually lower the production of good cows, at the same time they are more economical than the commonly accepted feeding methods because of their lower cost. This latter work will, it is believed, also provide a basis for adjusting milk production to consumer demand even though more efficient production is obtained through better breeding practices.

Nearly half of the entire amount of milk produced in the United States annually is used in the fluid state for human consumption. Much of this milk is rejected by buyers or reaches the market in a condition that makes it either unsalable or salable only at a reduced price. Milk of low quality often has undesirable flavors and other disagreeable characteristics which prejudice consumers against its use. The loss to dairy farmers due to low-quality milk amounts to millions of dollars annually. Pure, wholesome milk is essential to proper nutrition and a decent standard of living. Formerly much disease, especially among infants, was caused by carelessly produced and handled milk. This has been largely eliminated through application of the results of research, but much work remains to be done in order to bring the milk supply of the Nation to a uniformly high level of quality.

Milk surpluses occur from time to time due to seasonal fluctuations in production and economic conditions. Because surplus milk has a demoralizing effect on the market, it is important to devise means for extending the markets for fluid milk and for getting it to the consumer more efficiently and economically through the application of newly-developed methods of refrigeration, concentration, and sterilization.

It is possible to control quality in the manufacture of dairy products only through a knowledge of the bacteriological and chemical changes involved and the application of this knowledge to factory processes. This requires research to provide the basis for formulas and

rules applicable to factory conditions. Defects in quality are usually the result of insufficient knowledge of the factors influencing flavor or texture and of the methods controlling these factors under commercial conditions.

General plan: The work is organized and conducted under three research projects: Investigations of milk and butterfat production of dairy cows; market-milk investigations; and investigations of the utilization of milk in the manufacture of milk products. It is carried on through field and laboratory experiments in cooperation with State colleges, agricultural experiment stations, and extension services, other Government agencies, dairymen, and manufacturers of dairy products. Some phases of the work are conducted cooperatively in each State and in Hawaii and Puerto Rico. Breeding experiments are conducted to ascertain the comparative effects of different methods of breeding in fixing an inheritance for high and uniform levels of producing ability in dairy cows; to develop methods for judging at an early age the potential producing ability of heifers in order to avoid raising to maturity those heifer calves that should be discarded because of inferior milk-producing ability. Other phases of the production research are the effect of nutrients on growth, reproduction, health, and yield and composition of milk, and the effect of the application of breeding and feeding practices on the level and economy of production. Laboratory research includes work to discover the basic faults in the production of market milk and to devise remedies which can be readily and economically applied; and milk manufacturing problems designed to increase the returns to the producers of milk by (a) increasing consumption through improvements in quality of milk products, such as butter, cheese, ice cream, condensed and evaporated milk; (b) lowering the cost of manufacture through increased efficiency and reduction in the proportion of undergrade products; and (c) converting byproducts of milk into marketable form.

Examples of progress and current program: The following are examples of recent accomplishments under this appropriation.

Investigations of milk and butterfat production of dairy cows: Breeding experiments with cattle are necesssarily slow, but the experiments in which meritoriously proved sires are used for generation after generation, in an effort to fix an inheritance for high levels of production, are making definite progress. Criteria by which this progress may be measured are the relative producing ability of the cows by generations, the decreased frequency with which low-producing animals appear, and the transmitting ability for level of production of the bulls resulting from these matings. The production records of cows in the Beltsville herd give a measure of results that are being obtained. Thirty-four Holsteins in the foundation herd had an average production on a mature basis of 678 pounds of butterfat. One hundred and six tested daughters of five proved sires used in the herd have an average production of 719 pounds of butterfat. The fifth proved sire now in use has

28 tested daughters with an average yield on a mature basis of 808 pounds of butterfat. Forty-three cows in the foundation herd of Jerseys averaged 622 pounds of butterfat on a mature basis. Forty-two cows in the present herd, most of which are the product of three direct crosses of meritoriously proved sires, have an average production on a mature basis of 743 pounds of butterfat. In both the Holsteins and Jerseys the percentage of low-producing daughters has declined with each generation of proved-sire mating, indicating that the germ plasm is gradually being purified for a high level of production.

Approximately 80 percent of the sons of meritoriously proved-sire matings, have improved the level of production in the herds in which they were placed for proving.

The outstanding results from these breeding experiments led the New York State Extension Service and the Chautauqua County Farm Bureau to obtain the loan of bulls from the Beltsville experimental herd to be placed in selected herds in Chautauqua County for the purpose of producing superior germ plasm for high levels of production that would subsequently be disseminated to other herds in the county.

The breeding experiments with dairy cattle being conducted by the Bureau of Dairy Industry are the only ones in existence that are proceeding according to a detailed plan and under carefully controlled environmental conditions. Data will continue to be accumulated and will eventually be of inestimable value to the entire livestock industry of the country. These data will be analyzed and published as rapidly as facilities will permit.

Preliminary results of investigations designed to provide a basis for evaluating the potential milk-producing capacity of young calves show very definitely that the degree of development of the mammary gland in young calves is indicative of their producing capacity as cows. It has been determined that a definite relationship exists between development of the chest and paunch of dairy calves and their later development as cows. This is indicated by correlation coefficients of cross-section areas of these regions taken at young ages and again at 2 to 3 years of age and again when mature. In other words, the calf with a large development of chest and paunch will also have a superior development of these parts when it reaches maturity.

In a study of Holsteins it was found that the veining on the surface of the udder - usually looked upon as a desirable characteristic - was more pronounced on udders commonly considered poor in quality. The results obtained with Jerseys were less marked. No relationship was found between udder quality and the development of the abdominal milk veins or the size of the milk wells in either of the two breeds. No significant correlation was found between udder veining, milk veins, or milk wells and producing capacity.

Further studies of the relation of conformation to milk-producing capacity will be made, and results analyzed to determine the relationships,

if any, that exist between development of body parts and production ability as an aid to dairymen in discarding potentially low producers from their herds.

Feeding and management investigations have been pointed toward methods of producing cheaper feed nutrients, the improvement of pastures, and the efficient preservation of legume and grass crops as silage.

Crimson clover and hairy vetch sowed on blue-grass pastures in the fall without any soil preparation increased the yield of dry material as much as 1,000 pounds per acre without damage to the bluegrass sod. The cost of producing digestible nutrients in this manner varied from 30 to 60 cents per 100 pounds, or from one-third to one-half the cost of producing digestible nutrients in the form of homegrown hay or corn silage. The use of superphosphate or lime, or both, for top dressing pastures did not materially increase yields, but a decided increase was affected through the use of barnyard manure. Annual pasture crops requiring soil preparation every year are uneconomical. Yields are low and the costs were high as compared to permanent pastures. Furthermore, they did not extend the pasture season materially, although some of them, such as lespedeza, soybeans and Sudan grass, did provide grazing in mid-summer when blue grass is likely to be short.

The quality of soybean silage was definitely improved by the addition during ensiling of from 20 to 25 pounds of salt to each ton of green material of high-moisture (78 percent) content. The addition of similar quantities of salt to alfalfa having a low-moisture (69 percent) content had no appreciable effect, as all of the silage was uniformly good. The addition of dry hay or ground corn to high-moisture crops resulted in an excellent quality of silage. It was found that good silage could be made by wilting hay crops to a point where no juice would be expressed and run out of the silo. Equally good results were obtained by adding dry hay or ground corn if wilting is not practicable without any cash outlay for preservative. Alfalfa hay which had been dried in the field almost enough to permit its safe storage was preserved successfully in a silo, and the resulting product was equal and in some respects superior to No. 1 hay in feeding value. Contrary to previous attempts, a palatable silage was made from lespedeza sericea. The difference in palatability could not be ascribed to the moisture content or to the addition of either acids or molasses. Less tannin in the sericea, or the presence of about 10 percent of grass in the crop possibly improved the palatability of the silage. Soybean silage was not found to be equal in feeding value to corn silage. The addition of either dry hay or corn silage to a ration in which grass silage was the only roughage, increased the yield of milk. On the basis of dry-matter content, grass silage is equal to the best field-cured hay that could be made from the same crop.

Work under this project will be continued along the following lines: The relative economy and productivity of permanent pastures as compared

with those rotated with other crops; the adaptability of certain new plants for pasturage; the use of propionic acid to prevent molding of silage; the effect on production of housing cows in stalls on concrete floors, and housing them in sheds where they run loose and stand on accumulated bedding and droppings; relative values of prairie-grass hay and pasturage for milk production; relative efficiency of one grain as compared to grain mixtures for supplementing good leguminous roughage for milk production; and the comparative cost, efficiency and returns of top-dressing pastures on soils of varying degree of fertility with liquid manure drained from the cow barn.

Accurate chemical methods for the determination of serine and threonine were developed and applied to the study of these constituents in casein, lactalbumin, lactoglobulin, and other proteins. It has been found that little or no hydroxyglutamic acid is present in milk proteins, although for 20 years this substance was considered an important constituent of casein. These investigations have led to studies of the chemical reactions of proteins important in nutrition, the use of proteins in industry, and possibly in the synthesis of proteins in the plant.

It has been demonstrated that milk and liver extracts contain still-unidentified nutrients which, when included in quantities as small as 2 mg. daily in diets containing all of the now known nutrients in amounts adequate for optimum growth, increase the rate of growth of rats by as much as 90 to 100 percent over that of their litter mates. Precocious development of the reproductive organs was also noted. The nature, physiological action, and distribution of these unidentified factors are now being studied, especially in relation to the production and utilization of milk.

Investigational work with material occurring in the juice of the corn and oat plants developed that this material brings about precocious vaginal opening and ovarian activity in the rat, stimulates development of the ovaries and uteri in the young female rats, and the prostate gland and seminal vesicles in the young male rat. The study of the nature and occurrence of this material in plants and its mode of action in the animal are being continued. The results of this work should be important in connection with the effect of pasture on reproduction in cattle.

Cod-liver oil when fed cows at the rate of 50 or 100 ml. a day for 30 days reduced the fat test in their milk; 30 ml. of cod-liver oil fed daily for 30 days did not reduce the fat test; but, in the milk of 83 percent of the cows fed 10 or 20 ml. of cod-liver oil daily for years, the fat test was lower than in the milk of the dams which received no cod-liver oil in their ration. When neither daughters nor dams received col-liver oil, the fat test in the milk of 58 percent of the daughters was higher than in the milk of the dams. Cod-liver oil is used to supply vitamin A in certain cattle rations, and is known to produce destructive changes in muscle tissue of some herbivora through destruction of vitamin E. Mechanism of this effect will receive further study.

Incomplete results indicate that, for best results, young calves must be allowed close to 290 micrograms of carotene or 75 micrograms of vitamin A daily per kilogram of body weight during the first month of life. If skim milk is fed, this vitamin A may be supplied by feeding finely ground or grated carrots suspended in the milk, or cod-liver oil, or other feeds potent as sources of vitamin A.

The effect of various farm rations on growth, production, reproduction, health and duration of productive life of dairy cows, the nutrients in various farm feeds, the nutrient requirements of cattle both in respect to known and still-unidentified factors, and the adequacy and supplementation of various rations as sources of minerals, are subjects for continued investigation.

During the past 10 years the average milk and butterfat production of cows in dairy-herd-improvement associations has increased more than 650 and 36 pounds, respectively. Feed and production records obtained in dairy-herd-improvement associations are currently summarized and analyzed to provide information with which dairymen may improve their herds through effective culling, by adopting improved feeding practices, and by carefully selecting breeding stock.

Through the proved-sire program the inheritance of association herds for high-producing efficiency is being further improved and the superior hereditary influence of association herds is being widely spread. Identification records for more than 1,000,000 animals have been established and production records for more than 500,000 cows have been received. Data are being accumulated on approximately 70,000 sires of which more than 7,500 have been proved, the records of which have been given wide distribution in order than dairymen may fully utilize the superior breeding stock found in association herds. During the past year the fifth annual list was published, which included the names and records of 3,519 proved sires.

In cooperation with the States, leadership is given the organization and operation of cooperative breeding associations. Through these associations outstanding proved sires are used extensively and their superior hereditary influence fully utilized. Five thousand, four hundred and seventy-two herds consisting of 41,678 cows are now provided with sire service through 277 cooperative associations. Twenty-seven artificial breeding organizations are providing breeding service for approximately 3,000 herds consisting of more than 34,000 cows.

The dairy-herd-improvement association work in the States will continue to be sponsored and given leadership in cooperation with the State colleges. Data obtained in association herds will be summarized and analyzed in order to supply dairymen generally with information with which to improve the producing capacity of their herds.

Market-milk investigations: Studies were carried on to ascertain whether goats' milk could be successfully pasteurized. Both the "holder" and "high-temperature short-time" systems were used. Contrary to

popular belief, it was found that goats' milk may be pasteurized with little or no dimunition of its nutritive qualities. Continued studies with mastitis, an udder disease of dairy cows, indicated that machine milking may cause greater irritation of the udder, as shown by increased chloride content and leucocyte count of the milk. Much progress has been made in evaluating present tests for mastitis and devising improved methods so that cows may be quickly segregated for treatment. Further investigations will be made to discover the effect of certain dairy practices on the incidence of mastitis. Chemical tests were concluded to determine the corrosive effect of chlorine and lye solutions on metals used in dairy equipment. Studies are under way on the comparative reliability of tests for milk quality for the purpose of developing simple and accurate methods.

A method of preparing high-quality sour cream in the home was evolved. Proper methods of homogenizing milk have been worked out, so that it is now possible to produce milk of a uniform and desirable appearance and flavor. Digestion experiments have shown that homogenized milk has a soft curd and is more readily digested than untreated milk. Oxidized flavor is one of the most common defects of milk. Preliminary work has been done to ascertain the causes of oxidized flavor in milk and methods of preventing it by proper feeding practices and subsequent treatment.

Studies were completed on the marketing of special grades of milk in Richmond, Virginia. The volume of such grades is comparatively small but there has been a steady increase in sales. Revision of information on milk-plant equipment was completed and made available for the guidance of operators, both large and small. Work was undertaken with dairymen in Maryland, West Virginia, Virginia, and Pennsylvania on a study of costs and methods of producer distribution of fluid milk. This study when completed will aid dairy farmers in determining the most profitable disposition of their milk.

Investigations of the utilization of milk in the manufacture of milk products: The work of this project is designed to improve the quality of dairy products, increase the efficiency of established practices, develop new processes and products, and in general add to the information essential to the proper handling of milk and its manufacture into various products.

Research of an abstract nature yields results which may have unforeseen application in various fields. Methods devised for the fractionation of milk fat will be used to separate the fat into fractions of known composition and of sufficient volume to determine their nutritive value. Equipment has been installed and work started on a study of the proteins of milk, using newly-developed technique of ultra-centrifugal separation and microchemical analysis. Early experiments have demonstrated the possibility of mechanically separating casein into fractions. The next step will be the determination of the chemical nature, physical properties, and possible uses of these fractions. Taxonomic studies on the

lactobacilli, an important group of dairy bacteria, have been carried to a point which makes classification on a sound basis possible, and definitely establishes the identity of the culture used in assaying vitamin B_2. Studies will be continued on the production and utilization of vitamins by bacteria.

Studies of the factors which influence the overrun and texture of ice cream are developing a system of scientific control over the manufacturing process which will make it possible to secure uniformity in the physical properties required by the consumer. New ways of incorporating a greater proportion of milk products in ice cream have been developed and established commercially. Data obtained in studying the causes of deterioration of butterfat in storage show that cream may be so handled as to make possible its storage for periods up to a year without appreciable deterioration in flavor. Plans for the immediate future include a study of the effect of gelatins, alginates, and other stabilizers on overrun and texture.

Investigations are under way to determine the maximum amount of cottonseed meal, soybean meal, and other oily feeds which can be included in the ration of dairy cows without appreciably affecting the texture or flavor of butter. This work has shown that very small amounts of certain feeds have a noticeable effect and will be continued until the safe limit for each feed is determined. It has been found that deterioration of butter, whole-milk powder, and, to a somewhat less extent, skim-milk powder is due to an oxidation of the fat and fat-like constituents. The combinations of factors which control the rate of this oxidation are gradually being found and eventually it should be possible to eliminate the greater part of this undesirable change. The demand for substitutes for metals commonly used in the dairy industry has stimulated activity in converting lactic acid, made by the fermentation of milk sugar, into lacquers which may be used as a substitute for tin in protecting steel from the action of milk. A lacquer has been perfected which gives promise under laboratory conditions and which will be subjected to the more rigid factory tests. Investigations of means of utilizing the milk solids remaining in whey after the curd of Cheddar or Swiss cheese is removed have resulted in the production of a cheese which, if it can be developed into a marketable product, will increase the value of cheese milk 30 or 40 cents per hundred pounds. A sirup has been made by subjecting acid milk-sugar solutions to high temperatures, thus converting the lactose into a mixture of lactose, galactose, and dextrose and making a product comparable to ordinary glucose sirup. A new method of heating is now available which is expected to reduce materially the cost of inversion and, if successful, will make it possible to convert large quantities of whey into a marketable product.

Equipment has been obtained in which milk may be heated for short periods without exposure to air at temperatures well above the boiling point. Preliminary experiments have shown that by using high forewarming temperatures evaporated milk may be sterilized without the addition of

chemicals and that with milk of good quality the concentration may be increased materially without encountering objectionable curdling in sterilization. Thus, it is possible to decrease the amount of tin and volume of shipping space per unit of milk by as much as 25 percent. Applications of this system which are being investigated include the possibility of sterilizing evaporated milk without objectionable changes in flavor; the effect of high-temperature, short-time forewarming and sterilization on the viscosity, separation of fat and crystal formation in storage; the changes in viscosity in sweetened-condensed milk in storage; and the preparation of skim-milk powder especially adapted to bread making.

A method of control in the manufacture of Swiss cheese has been developed and put into commercial practice which has greatly reduced the proportion of undergrades. In some conditions undergrades are produced for which no control has been found. Field investigations in the past year have tended to eliminate feed, diseases of the udder, and other farm conditions as causes for undergrade cheese. This line of investigation will be continued with attention concentrated on factory conditions. Assistance has been given to factories making cheese of the Roquefort type, and an adequate domestic supply of this cheese will probably be available. Work is in progress on other varieties of cheese not previously make in this country and manufacturing methods may be expected to be developed during the coming year. Modifications of the conventional method of making American Cheddar cheese have been developed which make it possible for the average factory to manufacture a uniformly high grade of cheese. The value of this new procedure has been demonstrated in a number of commercial factories.

SUPPLEMENTAL FUNDS
(Complete Bureau Statement)

Direct Allotments

	Allotments 1941	Estimated allotments, 1942	Estimated allotments, 1943
Special Research Fund, Department of Agriculture: For special dairy cattle and dairy products research	$73,980	$59,300	$53,020
Emergency Relief Appropriation Act of 1941: Coding, indexing, tabulating, checking, and completing a genealogical and production record of animals in the Dairy-Herd-Improvement Program	36,034	---	---
TOTAL, Supplementary funds (direct allotments)	110,014	59,300	53,020

BUREAU OF PLANT INDUSTRY

(a) GENERAL ADMINISTRATIVE EXPENSES

Appropriation Act, 1942, plus $2,813 supplemental for within-grade promotions	$212,755
Budget Estimate, 1943	213,710
Change from 1942:	
Reduction in working funds	- 1,942
Additional for within-grade promotions	+ 2,897
Net increase	+ 955

PROJECT STATEMENT

Projects	1941	1942 (estimated)	1943 (estimated)	Increase or decrease
1. General administration and business service	$208,553	$209,942	$208,000	- $1,942 (1)
2. Net cost of within-grade promotions	- -	2,813	5,710	+ 2,897
Unobligated balance	1,389	- -	- -	- -
Total appropriation	209,942	212,755	213,710	+ 955

DECREASE

(1) The decrease of $1,942 in working funds under this item for 1943 will be met by discontinuing the services of one CAF-2 clerk, and curtailment in replacement of equipment.

WORK UNDER THIS APPROPRIATION

This appropriation provides for the direction of the research work of the Bureau of Plant Industry, general administration and supervision of fiscal, property, and personnel work, and the administrative review and preparation of research and other publications, including bibliographical and related work.

(b) ARLINGTON FARM

Appropriation Act, 1942, plus $900 supplemental for within-grade promotions	$50,314
Budget estimate, 1943	51,109
Change from 1942:	
Additional for within-grade promotions	+ 795

PROJECT STATEMENT

Projects	1941	1942 (estimated)	1943 (estimated)	Increase or decrease
1. Arlington Farm: Maintenance of facilities for basic plant research	$49,132	$49,414	$49,414	- -
2. Net cost of within-grade promotions	- -	900	1,695	+ 795
Unobligated balance	282	- -	- -	- -
Total appropriation	49,414	50,314	51,109	+ 795

WORK UNDER THIS APPROPRIATION

This appropriation provides for general maintenance and farm facilities of the Arlington Experiment Farm, Rosslyn, Virginia, which is now in process of relocation and reestablishment at a new site near Beltsville, Maryland, under authority of Public No. 885, 76th Congress, and with funds provided to the War Department for transfer to the Department of Agriculture by the First Supplemental Civil Functions Appropriation Act, 1941.

By virtue of these Acts of Congress, the Arlington Experiment Farm is being released progressively to the War Department as necessary facilities for experimental work become available at the new site. Thus far virtually all of the farm land of the Arlington Experiment Farm has been released to the War Department, only portions of the farm being retained where the farm buildings, greenhouses, laboratories and other similar facilities are located. This land, also, together with all buildings thereon, is being released as rapidly as buildings now in process of construction are completed at the new site.

Pending complete removal from Arlington Experiment Farm it has been necessary to maintain the buildings, laboratories, greenhouses, etc., in order not to jeopardize unduly the experimental work in progress there. At the same time it has been necessary, at the new site, to take essential steps preparatory to the full inauguration of experimental work as early as practicable.

Thus the work done under this appropriation since enactment of Public No. 812, dated October 9, 1940, has been in progress concurrently at both the old and the new site. Authority for this dual operation is carried in the appropriation language. This procedure of necessity will continue until the removal and reestablishment program is consummated. At that time the new site will become headquarters for the Bureau of Plant Industry, all or practically all of the Washington personnel being transferred with the Arlington personnel. A new designation for this appropriation will then be recommended.

Progress made at the new site for headquarters of the Bureau of Plant Industry includes the purchase of most of the necessary land, the erection of service buildings, greenhouses, and headhouses, many of which are practically ready for occupancy; contracting for the erection of four laboratory and office buildings, and installation of most of the necessary service lines, including gas, water, steam and electricity. Laboratory facilities for farm implement investigations of the Bureau of Agricultural Chemistry and Engineering and cereal and forage insect investigations of the Bureau of Entomology and Plant Quarantine, formerly at Arlington Farm, are nearly completed at the Beltsville Research Center.

(c) REMOVAL AND REESTABLISHMENT OF ARLINGTON FARM, VIRGINIA
(Transfer to Agriculture)

This budget schedule covers obligations under the nonrecurring appropriation of $3,200,000 provided in the First Supplemental Civil Functions Appropriation Act, 1941, as an urgent item in the defense program in order that Arlington Farm might be released in its entirety for military purposes. The removal activity is discussed under the immediately preceding item for Arlington Farm.

(d) CEREAL CROPS AND DISEASES

Appropriation Act, 1942, plus $3,878 supplemental for within-grade promotions	$580,478
Budget Estimate, 1943	558,160
Change from 1942:	
Reduction in working funds	-26,600
Additional for within-grade promotions	+ 4,282
Net decrease	-22,318

PROJECT STATEMENT

Projects	1941	1942 (estimated)	1943 (estimated)	Increase or decrease
1. Barley investigations	$60,000	$60,109	$56,129	- $3,980 (1)
2. Corn investigations	143,100	144,561	139,796	- 4,765 (1)
3. Seed Flax investigations	21,200	30,513	26,093	- 4,420 (1)
4. Sorghum investigations	24,500	24,534	23,759	- 775 (1)
5. Oat investigations	39,414	39,559	38,974	- 585 (1)
6. Rice investigations	42,000	43,098	41,503	- 1,595 (1)
7. Wheat investigations	190,700	194,226	186,061	- 8,165 (1)
8. Weed investigations	39,450	40,000	37,685	- 2,315 (1)
9. Net cost of within-grade promotions	- -	3,878	8,160	+ 4,282
Unobligated balance	4,636	- -	- -	- -
Total appropriation	565,000	580,478	558,160	- 22,318

DECREASE

(1) The decrease of $26,600 in working funds under this item for 1943 is distributed by projects as indicated in the project statement. These reductions contemplate curtailment in cereal breeding, disease, cultural, and quality investigations conducted in cooperation with 16 State agricultural experiment stations, and in cooperative weed control investigations in Nebraska, with curtailment of work in Washington, D. C.

Personnel reductions contemplated under the decrease are shown in the following tabulation, the first column of which indicates personnel to be released, and the second column anticipated vacancies that will not be filled:

Departmental:	2 P-1 Junior statistician	1 P-1 Junior editor 1 CAF-5 Senior Clerk
Field:	1 Agent 1 Agent, part-time	1 P-2 Asst. agronomist 1 P-1 Jr. agronomist

The estimated distribution of the decrease by locations is as follows:

California, Biggs	$ 250
District of Columbia	10,700
Idaho, Moscow	100
Iowa, Ames	1,950
Kansas: Hays	130
Manhattan	1,920
Minnesota, St. Paul	820
Missouri: Columbia	500
Elsberry	150
Montana, Bozeman	450
Nebraska, Lincoln	2,300
New Mexico, Tucumcari	150
New York, Ithaca	100
North Dakota, Fargo	3,550
Ohio, Wooster	600
Oregon: Moro	100
Pendleton	1,000
South Dakota, Brookings	100
Texas: Beaumont	250
Big Spring	150
College Station	100
Dalhart	150
Washington, Pullman	1,080
	$26,600

WORK UNDER THIS APPROPRIATION

Objective: To insure economy and stability in growing the Nation's food and feed grains and to improve their quality by eliminating preventable hazards through (1) improving cultural, cropping, and harvesting methods; (2) breeding varieties better adapted to avoid hazards peculiar to the different parts of the country; (3) developing methods for controlling diseases and pests; and (4) devising practical systems of culture, cropping, and chemical treatments for the control of noxious weeds.

The problem and its significance: Unpredictable fluctuation in the yield and quality of the grain crops is a seriously disturbing element in our national economy. Most of these fluctuations are due to losses from diseases and insect pests, and to the effects of cold, heat, or drought. As an example, stem rust of wheat in 1904, 1916, 1935, and 1937 caused losses in excess of $100,000,000 each year. In 1938 a combination of stem rust, leaf rust, and heat resulted in an equally serious cut in spring wheat and oat yields. In the winter of 1939-40, 20 percent of winter wheat sowings were lost from winterkilling. The normal loss amounts to 10 percent. Other diseases and heat and drought are added hazards. The fact that such losses are not equally distributed, but may wipe out almost the entire crop of individual producers or even of entire producing sections, adds to their seriousness.

Research has demonstrated that, through breeding, strains of the different crops can be developed for each area, which because of disease resistance or other better adaptation to prevailing conditions, may greatly reduce fluctuations in yield and quality. Improvements in cropping and cultural methods and seed treatments also can reduce losses. Proper attention to all of these considerations opens the way through research for more profitable and certain production of these basic crops.

Weeds are estimated to cause an annual loss through reduced yields, lowered crop quality, and costs of control, etc. in excess of $1,000,000,000, and by some authorities as much as $3,000,000,000. Noxious weeds, particularly difficult to control, threaten the continued use of extensive valuable acreages. Land values, tax structures, etc. are seriously impaired by these pests.

General plan: Research on improvement in cultural and cropping methods, disease control, breeding, and on methods to avoid various hazards, is conducted throughout the United States in the regions where the different crops are important. This includes work at central points where special equipment is made available for intensive studies on diseases and for developing information on cold, heat, and drought resistance for field use and in the breeding program, and also work in the field. The entire program is cooperative with the State Agricultural Experiment Stations, and much breeding material and information are supplied to the State stations even when there is no formal cooperation. Formal cooperation is maintained with the States and work is conducted in New York, West Virginia, Georgia, Tennessee, Louisiana, Arkansas, Missouri, Ohio, Indiana, Illinois, Wisconsin, Iowa, Minnesota, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, Arizona, California, Nevada, Utah, Idaho, Montana, Oregon, and Washington.

Examples of progress and current program: Examples of recent accomplishments are cited to show progress on one or more phases of the broad problem involved. Other phases of the general problem are indicated which require attention as a next logical step in solving the broad problem as a whole.

Project 1. Barley investigations

Breeding better barleys: Sunrise, a winter variety with stiff straw and resistant to mildew and to covered smut and one form of loose smut, is being distributed for growing in the Southeast. Wintex, also a winter variety, has been distributed in Texas, where it has proven superior to the commonly grown commercial sorts. The value of winter barley as a winter cover to prevent soil erosion and for fall, winter, and early spring pasture, is responsible for a greatly increased interest in the crop throughout the area where it can be grown. Mildew and leaf rust defoliate the plants in the fall, reduce the amount of pasture, and make the crop more susceptible to winter injury. These diseases, together with the smuts and stripe, are all widely prevalent and prevent the use of winter barley to the extent that it should be grown. The breeding of winter varieties adapted to the

different sections, resistant to the above named diseases, superior for pasture and grain production and more resistant to winter injury is the next step in the program.

Two varieties of spring barley, adapted in the drier areas, have been released during the past year, Compana in Montana and Beecher in Colorado and adjoining States. Resistance to the smuts and resistance to drought are the principal requirements to be met in further improvement.

Satisfactory methods have been developed to evaluate the malting quality of barley varieties. Studies in cooperation with the State stations of the north-central malting barley area extending over a five-year period have demonstrated that the newer smooth-awned stripe-resistant Barbless is equal to the old standard Oderbrucker in malting quality. The much higher yields and more pleasant handling of the Barbless, with its equal malting values, fully justify the displacement of the older standard Oderbrucker.

In the malting barley area, scab, leaf and stem rusts, stripe, and the smuts are hazards which reduce yields and lower malting and feed values. Scab in particular makes barley unfit for hog or horse feed. New materials involving crosses, the parents of which possess greater or less resistance to these diseases, show promise of possessing the desired disease resistance together with satisfactory yields and other qualities. All of these new strains are being tested for malting values, and every effort is being made to insure that any new introduction will be at least equal to present standard varieties in malting value before being released. Progress is encouraging and the program is being continued with promise of ultimate success.

Project 2. Corn investigations

Hybrid corn work advancing: Hybrid corn, the commercial development of which was made possible by the Bureau's program cooperative with the States, is now grown on more than 25,000,000 acres. In the important Corn Belt States hybrid corn is grown on from 50 to 75 percent of the total acreage. Average yields and quality have been markedly improved by the shift. In Iowa, for example, the State average acre yield in both 1939 and 1940 was above 50 bushels, compared with a previous normal of about 35 bushels.

Extensive tests are conducted with new and standard hybrids covering the entire corn-growing area. U. S. Hybrid 13 has given excellent yields in such tests in Ohio, Indiana, Illinois, Kentucky, Iowa, Missouri, Kansas, Virginia, and Maryland, and is as a result widely recommended and grown. The farm production of hybrid corn has been started in Tennessee and Louisiana, using hybrids developed in cooperation with those States. Yellow Paymaster and Yellow Thompson, derived from the widely grown white varieties Neal Paymaster and Thompson Prolific, have been distributed to farmers in Tennessee and adjacent States.

Genetic investigations, which made possible the original development of hybrid corn and upon which all improvements in breeding methods are based, are being continued. New selections more resistant to root-, stalk-, and ear-rots are being used to develop hybrids resistant to these hazards in order further to stabilize production. Attention is being given to strains able to produce satisfactory stands under cold, wet conditions, to strains capable of pollinating at high temperatures, and to strains which withstand injury from early fall low temperatures. Insect resistance is also receiving attention.

Project 3. Seed flax investigations

Experiments over a period of years in the Northern Great Plains have shown that it is impractical to attempt to control weeds, especially Russian thistle, by delaying the seeding date so as to permit late tillage of the land. The delay in seeding results in lower yields even though fewer weeds are present than in early seedings.

Wilt, pasmo, rust, and canker are the most serious diseases of flax in the major flax region. Much progress has already been made in combining resistance to these diseases into new strains. For example, Koto, a variety developed in experiments of this Bureau, has a high degree of resistance to wilt and rust.

Significant increases in yield of flaxseed have been obtained in experiments in southeast Kansas by including a legume in the rotation and by the application of barnyard manure, lime, and a phosphate fertilizer to the crop preceding flax.

Since the beginning of flax-growing in south Texas about five years ago, rust has caused serious losses. Seed of Rio, a new variety resistant to this disease introduced and increased in cooperative experiments, was planted on several thousand acres in 1941.

Formerly oil yield and quality were not considered in flax breeding, and the most widely-grown disease-resistant variety, Bison, is deficient in this respect. Continued research is necessary to develop disease-resistant varieties which yield a satisfactory quality and quantity of oil. A recent demand for flax straw fiber for use in making cigarette paper adds this factor to the breeding objectives.

Project 4. Sorghum investigations

The development of types suitable for combining has greatly increased the efficiency of growing sorghums for grain in the drier areas of the Southern Great Plains. The introduction of early-maturing varieties also has made possible the extension of sorghum production to the Northern Great Plains.

Two new diseases, pythium root rot and charcoal rot, have caused severe losses and in some fields complete failure in the southern Plains in recent years. Strains of most of the standard types highly resistant to the pythium disease have been isolated. Among others, a strain of resistant Wheatland milo was released to farmers in the Arkansas Valley of Kansas in 1941. In general, milos show the greatest damage from the charcoal rot, while feterita and hegari are intermediate and the kafirs and sorgos show varying degrees of resistance. The development of varieties of the milo and hegari types resistant to the charcoal disease is now one of the pressing problems in the sorghum program. Other pressing problems are the development of adapted varieties resistant to chinch bugs and to smut. Promising selections from some crosses have shown a high degree of resistance to pythium root rot, charcoal disease, smut, and chinch bugs but are not yet ready for release.

Project 5. Oat investigations

Oat crop improvement: As a result of the oat breeding program cooperative with various States, marked progress has been made in the development of new and productive varieties resistant to the smuts and to leaf and stem rust. Among these varieties newly distributed are Boone, Hancock, and Marion in Iowa; Vicland in Wisconsin; Huron in Michigan; Lenoir and Lelina in North Carolina; Fultex, Ranger, and Rustler in Texas; Uton in Utah; and Bridger in Montana. All of these varieties are more productive and of better quality than formerly grown sorts. Boone and Vicland in particular stood out during the rust epidemic of 1941 and as a result produced yields much superior to other varieties. Huron oats, grown in Michigan, gave the prize winning lots at the 1940 International Grain Show. Progress already made is indicative of what now must be done in developing similarly superior varieties for other areas. In particular there is need for more cold- and disease-resistant varieties for the South. These are required for winter soil cover to prevent erosion, to furnish fall, winter, and early spring pasture, and to supply needed hay and grain feed.

Project 6. Rice investigations

Superior rice varieties adopted: The varieties Rexoro, Nira, and Fortuna developed in the program cooperative with the Louisiana Station are now recognized as superior in culinary quality to even the widely grown Blue Rose heretofore recognized as the standard of quality. The acreage of these varieties is steadily increasing in the southern rice area, and they continue to command premium prices. In Arkansas the early better-quality variety Zenith, developed in the cooperative program in that State, is displacing the former standard Early Prolific. In California, where varieties developed in the Bureau's cooperative program occupy more than 95 percent of the rice acreage, a new stiff-strawed, medium-grain variety, Calady-40, has been distributed to meet a local demand for an adapted rice of this type. The breeding program is now centering on developing varieties for the southern area resistant to diseases, particularly certain leaf spots and neck rots which often cause serious reduction in yield and quality.

Project 7. Wheat investigations

Disease-resistant wheats: Stem rust, which caused heavy losses in the older varieties in the spring wheat region during the epidemics of 1935, 1937, and 1938, caused very little damage to the Thatcher variety. This variety, developed in cooperative experiments at the Minnesota Agricultural Experiment Station, was distributed to farmers in 1934, and in 1941 was grown on 7,000,000 acres in the United States and 12,500,000 in Canada. Thatcher, however, is susceptible to leaf rust, which was not previously considered a disease of major importance in the northern spring wheat region because its damage was masked by that of stem rust. In 1941 Thatcher was reduced in test weight and quality by leaf rust, and the problem is to produce a variety or varieties resistant to both stem and leaf rusts as well as stinking and loose smuts, and otherwise equal to Thatcher.

Stem rust spores from overwintering infections on wheat in Mexico and Texas, when conditions are favorable in the spring, supply inoculum for further widespread infection on wheat in Texas. Spores produced in Texas are in turn carried north by winds to infect other fields and when weather conditions are favorable there is a continuous build-up and spread of rust from original infections in south Texas clear to Canada. A resistant selection from a cross between Hope and Mediterranean is being increased for distribution in south Texas and should reduce this source of early-season inoculum. At present, however, there are no highly resistant varieties adapted to the greater part of the hard winter wheat belt extending from Texas to Nebraska. Emphasis is also being put on the breeding of resistant varieties adapted to this latter area.

Stem rust epidemics in 1940 and 1941 in California caused heavy losses in standard commercial varieties, but little loss in Baart 38 and White Federation 38, improved strains of Baart and White Federation bred for stem rust and bunt resistance.

Three new varieties, Sanford and Hardired, developed in cooperation with this Bureau, and Frondoso, introduced from Brazil, are being distributed in the Southeast. These leaf-rust resistant varieties are of special value in this area where the use of small grains for pasture and as winter cover crops is increasing. These varieties are not, however, resistant to loose smut and mildew which cause serious losses in this area, and further breeding work is under way to obtain adapted varieties resistant to these diseases.

Types of stem and leaf rust resistance formerly found only in Triticum timopheevi, a relative of cultivated wheat, have been recovered in bread wheat segregates from a cross between the two species. These resistant segregates while not suitable for commercial growing, are completely fertile in crosses with standard varieties and are being used to breed adapted varieties with these new types of resistance.

While resistant varieties have done much to reduce losses from the rusts in several areas, resistant varieties adapted to certain other areas where losses occur are not available. The problem is also complicated by the fact that many races of each of the rusts have been encountered, and new ones may be encountered which are able to attack wheat varieties resistant to the races now known. Recognizing the need for additional research on rust, and that measures (resistant varieties and seed treatment) for controlling stinking smut have reduced losses from that disease to a point where they can now be controlled within reasonable limits, the amount of research on stinking smut has been reduced and that on stem and leaf rusts is being increased.

Research on stripe rust, formerly conducted in the Pacific Northwest, has given information on the resistance of varieties and the influence of environment on the occurrence of the disease, sufficient to safeguard wheat growers from severe losses. Personnel and facilities engaged on stripe rust research have been assigned to research on loose smut of wheat which has caused heavy losses in the central and eastern States in recent years.

The research program on foot rots of cereals has been discontinued in the Pacific Northwest and transferred to the Northern Great Plains area. Research on the foot rots of cereals in the Pacific Northwest during the past 10 years has developed control measures which, if followed, will largely avoid losses from this disease; while during recent years foot rots caused by other organisms have caused serious losses in cereals and grasses in the Northern Great Plains.

Project 8. Weed investigations

Bindweed control measures: Recommendations for the control of noxious perennial weeds, particularly bindweed, have been greatly modified as a result of cooperative studies on the storage of root reserves combined with experiments on tillage and competitive crops. It has been found that the point of lowest vitality of roots of bindweed plants is just before blooming, and that tillage operations should begin at that time and be repeated at intervals of two weeks rather than one week as formerly recommended. Tillage for a season followed by the planting of vigorous growing competitive crops such as rye, alfalfa, or winter wheat, has given more satisfactory control of bindweed at a much lower cost than methods formerly recommended. Recommendations based on these results from research conducted by this Bureau, were followed on one-half million acres in 14 States in 1940. It now remains to determine the particular crops which offer the best competition to bindweed, and in the culture of which the information so far obtained may be utilized to allow profitable production and assured weed control.

(e) COTTON AND OTHER FIBER CROPS AND DISEASES

Appropriation Act, 1942 plus $2,625 supplemental for within-grade promotions	$446,160
Budget Estimate, 1943	430,820
Change from 1942:	
Reduction in working funds	-18,535
Additional for within-grade promotions	+ 3,195
Net decrease	-15,340

PROJECT STATEMENT

Projects	1941	1942 (estimated)	1943 (estimated)	Increase or decrease
1. Cotton investigations (production, improvement and diseases):				
(a) General cotton breeding and improvement investigations	$98,520	$99,020	$96,445	-$2,575
(b) Egyptian cotton breeding and improvement investigations	21,678	22,178	20,438	- 1,740
(c) Sea Island cotton breeding and improvement investigations	14,700	14,700	14,700	- -
(d) Cotton genetic investigations	50,910	51,160	48,535	- 2,625
(e) Studies of the structure and growth of the cotton plant and of cotton fibers	7,100	7,100	7,100	- -
(f) Cotton plant nutrition and other physiological investigations	64,175	64,500	61,850	- 2,650
(g) Cotton disease investigations	27,825	28,000	27,355	- 645
(h) Cotton quality research from the standpoint of production	31,125	31,200	27,900	- 3,300
(i) Cotton culture investigations	9,200	9,200	9,200	- -
(j) Investigations on establishing improved cotton seed stocks, including one-variety community methods	62,500	63,000	61,000	- 2,000
(k) Cotton soil-fertility and cotton root-rot soil and fertilizer investigations	34,311	35,190	33,190	- 2,000
Total, Cotton investigations	422,044	425,248	407,713	-17,535(1)

PROJECT STATEMENT - Continued

Projects	1941	1942 (estimated)	1943 (estimated)	Increase or decrease
2. Fiber plants other than cotton, investigations of:				
(a) Hard fiber studies	$7,685	$8,050	$7,700	- $350
(b) Fiber flax agronomic and breeding investigations	4,625	4,650	4,350	- 300
(c) Hemp investigations	5,567	5,587	5,237	- 350
Total, Fiber plants other than cotton, Investigations of	17,877	18,287	17,287	- 1,000(2)
3. Net cost of within-grade promotions	- -	2,625	5,820	+ 3,195
Unobligated balance	3,614	- -	- -	- -
Total appropriation	443,535	446,160	430,820	-15,340

DECREASE

The decrease of $18,535 in working funds under this item for 1943 consists of:

(1) A decrease of $17,535 under Project 1, Cotton investigations, distributed by work projects as indicated in the project statement. This contemplates discontinuance of cooperative one-variety community work in South Carolina; a reduction in cotton fiber analysis research in Washington, D. C.; curtailment in Egyptian cotton breeding at Sacaton, Arizona; curtailment of cotton soil-fertility investigations at Austin, Texas; and reductions in supplies, materials, equipment and other facilities for work in Arizona, the District of Columbia, Georgia, Mississippi, New Mexico, North Carolina, Oklahoma, South Carolina, Tennessee, and Texas.

(2) A decrease of $1,000 under Project 2, Fiber plants other than cotton, distributed by work projects as indicated. This will be met primarily by reducing travel of project leaders.

The estimated distribution of the reduction by States is as follows:

Arizona	$2,215
District of Columbia	9,145
Georgia	625
Mississippi	275
New Mexico	275
North Carolina	275
Oklahoma	275
South Carolina	2,275
Tennessee	275
Texas	2,900
	18,535

WORK UNDER THIS APPROPRIATION

General. Most of the work done under this appropriation pertains to cotton, its production, improvement, and diseases; only a small part pertains to other fiber crops such as hemp, flax, abaca, sisal, and henequen. The work with cotton, therefore, is emphasized in the following statement, but the other fiber crops named are of such significance, particularly in the present emergency and defense programs, that they are treated in separate paragraphs under the respective headings.

Objective: (a) To increase returns to growers of cotton in the United States and to strengthen the position of American cotton in domestic and foreign markets, by improving fiber quality, by developing effective disease control measures, and by devising cultural methods that will reduce costs of production while insuring to consumers the desired uniformity of product.

(b) To provide factual information basic to the production in the United States, or elsewhere in the Western Hemisphere, of fibers other than cotton (abaca, hemp, sisal, etc.) now largely imported, that have a high commercial and military use value.

The problem and its significance: (a) Cotton normally is the most important agricultural export from the United States. It is the principal source of income for one-third of the total farm population of this country. How to keep the cotton producing industry on a profitable basis, therefore, is a question of primary importance to American agriculture. Although desirable agricultural adjustments in cotton growing States may reduce the total cotton acreage, commercial requirements for cotton fiber will always command widespread farmer interest in this crop. Export markets, however, are becoming increasingly limited, and domestic markets more exacting. This means that producers of cotton must pay more attention than ever before to ways of increasing quality and of reducing costs.

(b) The United States annually imports between three and four hundred million pounds of abaca, sisal, and henequen, some ten million pounds of flax, and over a million pounds of hemp. These fibers are used in manufacturing rope, cordage, binder twine, textile fabrics, and other materials. Most of the abaca and sisal has heretofore been imported from the Orient and East Africa, the flax and hemp from Europe. With normal sources of supply cut off, the problem confronting the United States is one of establishing in this country, or elsewhere in the Western Hemisphere, adequate, dependable supplies of these essential plant fibers.

General plan: All cotton improvement and production work, involving both field and laboratory experiments, is cooperative with the State Agricultural Experiment Stations of the Cotton Belt, which act as a group in conformity with a coordinated plan of procedure. Certain fiber research is cooperative with the Agricultural Marketing Service, and with the Bureau of Agricultural Chemistry and Engineering. Other cooperation is with the Bureau of Entomology and Plant Quarantine, and with the Extension Service.

With fibers other than cotton, field investigations are made when advisable in foreign countries. Work with fibers adapted to this country is cooperative with State experiment stations and various Federal agencies. Work with tropical plants, as abaca, is cooperative with countries of Central and South America and with plantations operated in those countries.

Examples of progress and current program: The following examples of recent accomplishments under this appropriation are cited to show progress on some aspects of the broader problems confronted. Other aspects of these problems are also cited as indicating the next logical steps to be taken in the research program.

Project 1. Cotton investigations

Factors affecting quality of cotton: Variety seems to be the most important single factor influencing spinning value, according to fiber and spinning researches on 16 varieties of cotton grown at 14 stations in the Cotton Belt proper and 7 varieties grown in 4 locations in the Southwest. The strength of yarn made from different varieties grown at the same location and the same season has varied as much as 20%. The variation in the strength of yarns made from cottons grown at different places was found to be almost as great as that between varieties, and there is also considerable variation in the strength of yarn from the same varieties of cotton grown at the same location during different seasons. These variations, due to different varieties and to seasonal conditions and location effects, need further study in order to develop a more fundamental understanding of the more important factors influencing cotton quality.

Sea Island and American Egyptian cottons: Breeding work with the Egyptian types of cottons in the Southwest has progressed to the point where the entire American Egyptian producing areas in Texas, New Mexico and Arizona are planted to a variety (S x P) developed by this Bureau from stocks imported from Egypt some years ago. This variety is superior in quality to the ones from which it has been bred, and it is now being used for the more exacting needs in making fine goods, threads and other products requiring great strength. During the present emergency S x P is being used extensively for making balloon cloth for barrage balloons and for making certain parts of

airplanes, such as the inflatable pontoons for landing on water. Earlier, more productive types, with still greater fiber strength, are being sought in the breeding program, in order to compete with the best of the Egyptian types.

Sea Island cotton, which is the finest and strongest grown, has come into greater importance during the present emergency because of special needs in defense uses. This industry was revived from seed stocks furnished farmers by this Bureau 6 to 8 years ago and the breeding work which has been under way since that time has improved the strains and varieties to the point where American Sea Island is now again established as an important industry. The production is expanding under the pressure of special needs. This cotton is also going into balloon cloth, parachute harness, and other special defense articles. There is need, however, for additional work in breeding more uniform and productive varieties better adapted to the weevil infested areas and in breeding strains with longer staple to better meet special defense needs, such as cloth for man-carrying balloons for high altitude.

Unusual properties in cotton hybrids: One of the triple hybrids, produced by a special method for increasing the number of chromosomes so as to make it possible to combine species and varieties which could not otherwise be crossed, has a strength more than double that of ordinary cottons. By the same methods other cottons with unusual properties are being developed. In the cotton genetics garden at Stoneville, Mississippi, a green lint cotton, which contains 30 times as much wax as ordinary cottons, has been found and is now being increased as a possible source of wax with high melting point. This discovery is timely, since much of the wax for general use as a protective finish and polish has formerly been imported and is not available because of transportation difficulties. Means of producing and utilizing this wax in quantity remain to be developed. Other cottons of coarse fiber and high-yielding properties are being developed to take the place of Asiatic cottons formerly imported for blankets, upholstery and other special uses.

Cell wall structure related to fiber strength: Weather conditions during the period the cotton fiber is thickening evidently are important in determining the thickness of the wall and the strength of the fiber. It has also been found that there is a considerable difference among varieties as to the shape and size of the fibers and the structure of the fiber wall. The strength of the fiber is related to the orientation of the crystalline cellulose in the fiber wall and this orientation varies with varieties and is also influenced by growth conditions. The X-ray is being used to measure the angle of the crystalline cellulose to the main axis of the fiber and in this way a tool is provided for estimating the potential strength of the cotton produced by any particular variety. This affords a basis for selection and for evaluating the progenies which come out of the breeding and production researches. Means of simplifying the use of this technique are needed.

Reducing cotton disease losses: Cotton diseases are a large hazard on individual farms and take an estimated average annual toll of 1,700,000 bales. The loss was formerly much larger than this but through the research of the Department, in cooperation with the State experiment stations, certain measures of control have been developed, including varieties resistant to wilt, and the use of seed selection, seed treatment, and crop rotation to lessen the damage caused by anthracnose, angular leaf spot, etc. Much remains to be done to further improve these control methods and adapt them to soil conservation practices and other changes in our agriculture.

The Texas root rot (one of our most destructive diseases) is being studied intensively and the losses have been greatly reduced through crop rotations, use of organic manures, commercial fertilizers, improved cultural practices and other measures. In the irrigated sections of the Southwest, stable manure and green manuring crops have proved a positive means of control, but in Texas, where winter cover crops are not practical and the tonnage of green manuring crops that can be grown is not large enough to be effective, other measures must be developed.

Standardized cotton production: An outstanding result of the Bureau's work has been the organization, through cooperation with State Experiment Stations and Extension Services, of single-variety community production. In 1940, 201,392 farmer members in 1,896 one-variety communities in 545 of the 850 cotton counties in the 17 cotton States planted 4,454,245 acres, or about 18 percent of the total United States acreage, and produced 2,546,923 bales of superior quality cotton. The extra return to these grower members over and above what they would have received from the mixed, inferior cotton they formerly grew was estimated at $28,000,000. American manufacturers are pleased with the improved quality of the cotton from these areas and are regular customers in those districts where production has reached sufficient volume to attract buyers. A number of important problems in producing seed and in choosing varieties for the different areas remain to be solved. Marketing procedures are being arranged cooperatively with the Agricultural Marketing Service to insure that the production from one-variety communities reaches the spinners in pure variety lots, in order to realize more fully the value of standardized production.

Project 2. Investigations of fiber plants other than cotton

Fiber flax industry developing: Researches of this Bureau have resulted in the development of a fiber flax industry in this country. Varieties bred or introduced by the Bureau (in cooperation with the Oregon Experiment Station) were grown in 1940 on 12,000 acres, which is estimated to be almost enough to meet the needs for defense purposes in the present emergency. Without this home grown supply it would be very difficult for the Army, Navy and other defense agencies to secure fiber flax for parachute harness pull-cords, cords and threads for special uses, etc. Varieties of fiber flax have been developed which are superior to

foreign varieties upon which we were at first dependent. At the request of the Peruvian Government, the scientist in charge of this flax work is making a trip to that country to aid in developing a flax industry there to better supply the commercial and domestic needs with flax from the Western Hemisphere. Disease and production problems concerned with harvesting remain to be solved.

Hemp and abaca essential fibers: While we usually import more hemp than we grow, there are certain special needs (cordage, twine, and thread) in the Army and Navy for which this fiber is considered essential. The Bureau is breeding hemp for improved quality and higher yields and for freedom from marihuana. Production is being encouraged to care for defense needs, and the most urgent civilian uses.

Since abaca (Manila hemp) is essential for heavy cordage used by the Navy, Army, and industry--and since our entire supply comes from the Philippine Islands and the Dutch East Indies, and might be cut off during war--this Bureau brought seed stock from the Philippine Islands and began in 1925 to make experimental plantings in Panama. These have proved promising and one of the large U. S. plantation companies now has more than 2,000 acres growing there with adequate seed stock to develop the acreage required to meet our needs. Attention is being given to the solution of problems which might interfere with enlarged production, such as more economical methods of harvesting, cleaning and preparing the fiber for special uses.

(f) DRUG AND RELATED PLANTS

Appropriation Act, 1942, plus $120 supplemental for within-grade promotions	$48,620
Second Supplemental National Defense Appropriation Act, 1942	17,000
Total available, 1942	65,620
Budget Estimate, 1943	65,890
Change from 1942:	
Additional for within-grade promotions	+ 270

PROJECT STATEMENT

Projects	1941	1942 (estimated)	1943 (estimated)	Increase or decrease
1. Drug, oil, insecticide, tannin, flavoring and related plant investigations	$32,555	$54,555	$54,555	- -
2. Hop production and disease investigations	10,937	10,945	10,945	- -
3. Net cost of within-grade promotions	- -	120	390	+ 270
Unobligated balance	8	- -	- -	- -
Total appropriation	43,500	65,620	65,890	+ 270

WORK UNDER THIS APPROPRIATION

Objective: (1) To determine the agricultural possibilities, and to supply, as far as practicable, information useful in developing and maintaining commercial production in the United States, of plants that furnish the raw materials for medicines, flavors, paint and varnish oils, insecticides, tannin, perfumes, and related commodities; and (2) to develop through breeding varieties of hops that are resistant to downy mildew and other diseases and that produce higher yields of hops of superior quality.

The problem and its significance: The industries in the United States which manufacture medicines, insecticides, leather, flavoring extracts, paints, varnishes, linoleum, perfumes, and related products, are dependent to a very large degree on foreign sources for the plant materials that go into such manufactured products. In periods of world disturbance their procurement is frequently difficult, if not impossible. Some of the plants from which the desired materials may be obtained have been introduced in the United States and found adapted to growing conditions in some sections of this country, and some native plants are potential sources of certain of these materials. However, the cultural and production requirements of this group of plants are not well enough known, their management with respect to harvesting and processing not sufficiently understood, and the possibilities of developing superior adapted varieties not sufficiently determined to warrant their general use as crops by American farmers.

Since the quality of most crude drugs and related products is affected by various practices in connection with the culture, harvesting, curing, baling, and storing of the crop, it is necessary to determine the degree and importance of this relationship.

If adequate information can be developed on these problems to indicate how drug and related plants can be established as crops in this country and made reasonably profitable, the industries concerned will be furnished more dependable sources of raw materials of better and more uniform quality. Such new crops would further crop diversification, land utilization, and soil conservation programs, and provide cash crops non-competitive with presently established crops.

The American hop crop has a market value of about $10,000,000 annually. American brewers import annually from 6 to 8 million pounds of European hops, which they claim are superior. These normal sources of supply are now cut off. However, if the domestic crop can be improved through introduction or development of new varieties which are not only disease resistant but compare in quality with the preferred European type, the domestic production could be increased by the amount of these imports, thus providing for an additional 6,000 to 8,000 acres.

General plan: The work involves three distinct phases (1) field work including studies pertaining to propagation, culture, harvesting, curing, distillation and other processing, yields, and production expenses; (2) laboratory examination of materials obtained to determine their quality and the relation of various conditions and practices to quality; and (3) development through selection and breeding of varieties and types of superior quality and greater disease resistance. Since many species are involved and adapted to a wide range of conditions, the field work must be done in numerous locations throughout the United States. Most of the laboratory work and some field work is conducted at Beltsville, Maryland; however, most of the cultural, selection, and breeding work is conducted at Bureau of Plant Industry field stations and through cooperation with the various State experiment stations.

The investigation of hop disease problems, field control measures, and the breeding work are centered at Corvallis, Oregon, and conducted in cooperation with the Oregon Agricultural Experiment Station, with close cooperation with growers and county agents elsewhere in the State and in California and Washington. Three experimental hop yards totaling 7 acres are maintained for the purpose and greenhouse and laboratory studies are conducted in connection with the field work.

Examples of progress and current program: The following examples of recent accomplishments under this appropriation are cited to show progress on one or more aspects of the broader problems confronted. Other aspects of these problems are cited as indicating next logical steps to be taken in the research program.

Project 1. Drug, oil, insecticide, tannin, flavoring and related plant investigations

Botanical drugs for War-time needs: The botanical drugs used in the United States come from many parts of the world and supplies fluctuate greatly. The shortage of these imported botanicals with the resulting price increases has led to a great amount of interest in the possibilities of growing such plants as specialty crops in sufficient quantities to supply our domestic need. At the request of the Office of Agricultural Defense Relations, an analysis was made to determine what drug plants are of essential significance for our domestic needs and which of these plants can be grown in the United States. A report was made on the plants of essential significance including a comparative study of importations and prices over a period of years, and such general agricultural information was given as is available on climatic and soil requirements, cultivation, harvesting, and other problems likely to be encountered in growing these crops. The results of this study were also made available in the form of a circular as basic information helpful in avoiding exploitation of those people willing to grow these crops and useful as a guide to procedures for growing and harvesting such crops.

Work has been started to expand cooperative relationships with growers and with botanical drug firms to make this country self-sufficient in those drugs which can be produced here, including morphine, belladonna, digitalis, and others.

Emergency work with castor beans: In 1941, critical shipping conditions made it imperative to consider possible domestic sources of drying oils necessary to defense projects. At the request of the Office of Production Management, the Bureau of Plant Industry undertook a program to obtain information on suitable varieties and methods of growing castor beans in the United States as a means of providing this need. Tests, including all varieties of castor beans that had been grown in quantity sufficient to have some seed supply available, were made in 61 locations in the southern and central States ranging from Florida to California. Also 27 five-acre plots were planted in the regions thought to be most favorable for castor bean production to determine feasible and economic methods of growing castor beans with regard to type of soil to which they are adapted, methods of planting, influence of irrigation, extent and method of cultivation and response to fertilizers. Besides obtaining agronomic information, it is expected that the seed yield from these larger plots will be sufficient to make a nucleus of seed supply. Present methods involve a large amount of hand labor, and the crop is so new to most areas that much remains to be done in working out requirements for the several areas as well as better methods for harvesting and handling the seed. This work will be continued in the fiscal year 1943.

Insecticide plants of promise: Certain plants yielding products which are poisons specific for insects and non-poisonous to man have come into common use in replacing arsenicals and other poisons formerly used in combating household and agricultural insect pests. The most important of these are the rotenone-containing plants of South America and the East Indies and pyrethrum cultivated in Japan, Southeastern Europe, Africa and South America. Products of these plants have been imported for our domestic needs and emphasis in recent years has been on the development and utilization of these and other suitable native or exotic plants for growing these supplies in the United States.

At the request of the Office of Agricultural Defense Relations a study of the importations of the several plants and plant materials ordinarily used for making insecticide and raticide products was made and an analysis and summary of information on the crop possibilities of such plants was prepared and made available for distribution.

Investigations have shown that some plants of the native devil's shoestring (Tephrosia virginiana) contain a limited amount of rotenone in the roots in some localities. From these plants selections have been made and a few plants have been found with as much as 5% rotenone. Adaptation studies indicate large areas of the south suitable for growing devil's shoestring and present indications are that the rotenone content is fairly constant under different conditions. Work is in progress to make selections of plants with a greater rotenone content, and to develop economical methods of growing and harvesting the roots of this plant on a field crop basis.

Pyrethrum (Chrysanthemum cinerariaefolium) is the source of pyrethrin which is used extensively as the active ingredient in kerosene-base insect sprays. This plant has been grown in experimental plantings in many parts of the United States, and found to be adapted to the climate and soil of several regions. Harvesting of the crop has been a problem involving much hand labor, but a mechanical harvester which will pick the flower heads has been developed by this Bureau in cooperation with the Bureau of Agricultural Chemistry and Engineering, and proven as a practical and economical means of harvesting the flowers. Effective ways for drying the harvested crop of flowers need to be studied and developed. Selection of a better type of plant with regard to disease resistance and pyrethrin content is now in progress at several locations.

Sumac a potential source of tannin: The users of tannin products have repeatedly had to turn to new sources of tannin plants as usable stocks were exploited and became difficult to obtain. The leaves of several native species of sumac are potential sources of tannin and have long been collected in a limited way. In cooperation with the Bureau of Agricultural Chemistry and Engineering, a survey and analysis of the various species of sumac ranging from the New England States to Texas shows species of some promise in regard to the tannin content and possible use in tanning leather of certain qualities.

Also, this study has shown a very wide range in tannin content of plants of the same species growing in close proximity to one another. Selection for high yielding plants is now in progress. Preliminary field tests have demonstrated difficulties in establishing sumac in plantings as a field crop. Experiments are now under way to find a more efficient and economical way to establish the more desirable species (Rhus glabra and R. copallina) in field tests.

Hand methods of harvesting and drying the sumac leaves have been responsible largely for the very poor quality and lack of uniformity of domestic sumac. The development of more efficient methods of drying that will produce a uniform high quality product is necessary.

Project 2. Hop production and disease investigations

Combating hop mildew: Since 1930, when an outbreak of downy mildew in the hop yards in Oregon and Washington threatened to destroy the hop growing industry on the Pacific Coast, several important practices have been developed to control this disease. Crown treatment with various fungicides has greatly reduced early infection of the new growth of plants. Formulas for fungicidal dusts and sprays and methods of their application for most effective control of hop mildew have been devised and their efficiency determined. A formula for a spreader that greatly increases the effectiveness of fungicides has been developed.

All known domestic and many foreign varieties of hops have been grown in test yards and none has been found to have sufficient resistance to be grown without serious injury in regions where the disease occurs. These results have led to the development of a breeding program which is now under way to develop resistant varieties that are also desirable with respect to yield and quality.

The need for the production of seedless hops to meet competition with foreign hops has been demonstrated. This has led to a relatively large production of such hops in this country with a corresponding return to growers who have learned how to produce seedless hops of a quality formerly imported. Chemical and physical analyses have demonstrated an extreme range in the quality of hops of different varieties and grown under different conditions, and work is in progress to obtain information necessary for the grading and standardization of hops.

(g) DRY-LAND AGRICULTURE

Appropriation Act, 1942 plus $715 supplemental for within-grade promotions	$229,943
Budget Estimate, 1943	221,560
Change from 1942:	
Reduction in working funds	- 9,228
Additional for within-grade promotions	+ 845
Net decrease	- 8,383

PROJECT STATEMENT

Projects	1941	1942 (estimated)	1943 (estimated)	Increase or decrease
1. Dry-land agriculture investigations:				
(a) Dry-land field crop production investigations	$172,775	$177,262	$168,034	-$9,228 (1)
(b) Dry-land fruit and vegetable production investigations	28,011	28,277	28,277	- -
(c) Cooperative farm windbreak demonstrations and experimental test plantings	23,431	23,689	23,689	- -
2. Net cost of within-grade promotions	- -	715	1,560	+ 845
Unobligated balance	2,611	- -	- -	- -
Total appropriation	226,828	229,943	221,560	- 8,383

DECREASE

(1) The decrease of $9,228 in working funds under this item for 1943 contemplates discontinuing cooperative dry-land field crop investigations on State substations at Colby and Garden City, Kansas, and discontinuing at a State substation at Moro, Oregon, work under an increase provided for the fiscal year 1942; and a reduction in services at Beltsville, Maryland.

The decrease contemplates discontinuing the services of two cooperatively employed associate agronomists and one junior agronomist, the non-filling of an anticipated vacancy in an agent position, a reduction in temporary employees in the field, and curtailment in travel, supplies, and other expenses.

The estimated distribution of the decrease by States is as follows:

Kansas	$6,675
Maryland	153
Oregon	2,400

WORK UNDER THIS APPROPRIATION

Objective: To aid in developing a more stable agriculture under dry farming conditions in the Great Plains and under other semi-arid conditions, (a) by improving cultural methods and crop rotations whereby adapted crops can be combined in farm practices that will make the most efficient use of limited rainfall on different soil types for cash crop production and livestock requirements and (b) by making possible the successful growth of farm windbreaks and of fruit and vegetable gardens.

The problem and its significance: About one-fifth of the land area of the United States lies in semi-arid regions where light rainfall is the major factor limiting crop production. Except in a few scattered irrigated areas within this vast region, crops are produced successfully only by cultural methods that are conducive to the storage of rainfall in the soil and its efficient use by plants. Farm practice, therefore, must take full account of an erratic climate and varied soil conditions, and of crops and cultural methods peculiarly adapted to such conditions, if the advantages of a stable agriculture are to be realized.

In the Great Plains alone, dry farming is practiced on nearly half a million farms aggregating 107,000,000 acres of crop land. These farms comprise over half of America's total wheat acreage, three-fourths of the hard-red winter and spring wheat acreage, and large parts of the acreages devoted to flax, barley, oats, rye, corn, and cotton production. On many of these farms, pioneering practices have given way, or are giving way, to more mature practices, based upon the results of experience and experiment during the last forty or more years. With better information as to the true possibilities of soil and climate there is now developing a pattern upon which to base a permanent successful agriculture for the area. Closer understanding of the Plains environment, more widespread use of improved methods of soil management with respect to water storage, erosion, and crop requirements, adjustments in cropping methods and the use of improved varieties to meet drought, disease, insect and other hazards - all these are factors discernible in the progressive trend of agriculture in the Great Plains and other semi-arid regions.

There is a generally recognized need for additional factual information on cropping methods, crop rotations, grass establishment and utilization, home gardens, windbreaks, and general land use adjustments, if the present trend toward improved dry-land agriculture is to be maintained. This is particularly true in view of the task farmers now confront in meeting the problems resultant from earlier land policies that were conducive to exploitation, misuse, confusing ownership patterns, and to inequitable taxation; as well as the more recent

consequences of international disturbances and the effects upon market outlets.

General plan: The investigations are conducted, generally in cooperation with the State Experiment Stations or with other agencies of the Department, at (1) field stations maintained by this Bureau at Akron, Colorado; Tucumcari, New Mexico; Mandan, North Dakota; Lawton and Woodward, Oklahoma; Big Spring and Dalhart, Texas; and Sheridan, Wyoming; (2) field stations maintained by the Bureau's Division of Irrigation Agriculture at Huntley, Montana, and Newell, South Dakota; and (3) State substations at Colby, Garden City, and Hays, Kansas; Havre and Moccasin, Montana; North Platte, Nebraska; Dickinson, North Dakota; Pendleton and Moro, Oregon; and Archer, Wyoming.

At these stations facilities are provided, not only for the research work of the Bureau's Division of Dry-Land Agriculture, but also for work which is cooperative with various other divisions of the Bureau, such as Cereal Crops and Diseases, Forage Crops and Diseases; with other agencies of the Department, such as the Soil Conservation Service; and with the State Agricultural Experiment Stations of the several States. These stations provide the principal agricultural research facilities for this vast region of one-fifth of the United States.

Examples of progress and current program: The following examples of recent accomplishments under this appropriation are cited to show progress on one or more aspects of the broader problems confronted. Other aspects of these problems are cited as indicating next logical steps to be taken in the research program.

Relating soil moisture at seeding time to crops other than wheat: The previously reported finding that there is a definite relationship between soil moisture at seeding time and wheat yields, has been found to apply to milo grown in the Southern Great Plains, and preliminary evidence indicates that the same relationship may apply to other crops grown in dry-land areas.

The long-time records of yields obtained from different methods of cropping and soil preparation have made it possible to determine for each condition of soil and precipitation represented by the field stations the amount of stored water that is necessary to provide a specified degree of safety and the cultivation methods necessary to accomplish such storage. It was also found that the amount of available water in the soil can be estimated closely from observation of the depth to which the soil is wet. Frequent failures, low average yields, and infrequent good yields from wheat sown on soil wet to only one foot deep or less show that planting is not warranted under such conditions. Two feet of wet soil may provide a satisfactory margin of safety in some localities but not in others. Good yields have been best assured by an initial condition of 3 feet or more of

wet soil. This condition is found much oftener on fallowed land than on land cropped the previous year.

This definite information on the relationship of soil moisture at seeding time to wheat yields has influenced or determined lending policies of the Farm Credit Administration and the Farm Security Administration, has guided regulations of the Agricultural Adjustment Administration in adjustment programs, has been of basic value to the Crop Insurance Corporation in framing its regulations, and is being used extensively by county and State planning boards.

It remains now to determine more definitely the relationship of soil moisture at seeding time to yields of other crops utilized in dry-land areas, as a more complete basis for general farming, land use planning, adjustment programs, crop insurance and lending policies.

Cropping systems for dry-land areas: Experience and experimental evidence have shown that it is possible by proper cultural practice and through appropriate cropping and land management to develop a profitable agriculture in the dry farming areas. The protection and maintenance of the soil and the stability and permanence of agriculture under such conditions now appears to depend upon a proper balance and rotation of annual crops and perennial sod crops, varying somewhat for each condition of soil and precipitation. The solution of problems in using sod crops under dry-land conditions is the most prominent need in the program. The introduction of crested wheatgrass has meant much to the northern Plains and Intermountain regions, and it now remains to fit the grass most satisfactorily into farm practice, as well as to use it for land not suited to continued cultivation. All of this requires a continued and detailed research on the problem.

Farm families in dry-land areas are confronted with peculiarly difficult problems in the production of garden crops, owing to the limited number of adapted varieties and the necessity of developing cultural methods to offset the hazards of drought, cold, high wind and other extremes of climate. These problems are encountered also in efforts to establish and maintain trees and shrubs used in windbreak plantings for garden protection and home beautification. For these reasons experimental work has been in progress for several years that aims at the improvement of crops for such purposes and the development of satisfactory methods of cultivation.

Three varieties of tomatoes and two varieties of sweetcorn have recently been released, and some new varieties of fruits are ready for distribution. Other varieties are sufficiently promising to warrant the belief that further distributions can be made in the near future.

During the last 25 years, 4,600 cooperative demonstration windbreak plantings have been made on dry farms in the Great Plains. The length of useful life of such plantings is now becoming apparent and methods of maintaining or replacing them are being developed.

(h) FORAGE CROPS AND DISEASES

Appropriation Act, 1942, plus $2130 supplemental for within-grade promotions	$306,130
Budget Estimate, 1943	294,500
Change from 1942:	
Reduction in working funds	-14,000
Additional for within-grade promotions	+ 2,370
Net decrease	-11,630

PROJECT STATEMENT

Projects	1941	1942 (estimated)	1943 (estimated)	Increase or decrease
1. Alfalfa investigations	$59,173	$59,778	$56,948	-$2,830(1)
2. Clover investigations	26,625	26,821	25,421	- 1,400(2)
3. Soybean investigations	17,404	17,572	16,821	- 751(3)
4. Lespedeza, cowpea, and miscellaneous legume investigations	35,947	36,302	35,002	- 1,300(4)
5. Grass investigations	158,328	163,527	155,808	- 7,719(5)
6. Net cost of within-grade promotions	- -	2,130	4,500	+ 2,370
Unobligated balance	2,523	- -	- -	- -
Total appropriation	300,000	306,130	294,500	-11,630

DECREASE

The decrease of $14,000 in working funds under this item for 1943 includes the following reductions:

(1) Alfalfa investigations, $2,830. This decrease contemplates discontinuing cooperative alfalfa work with the Mississippi Experiment Station at Stoneville; and reducing work conducted in cooperation with the respective State experiment stations at Manhattan, Kansas; Baton Rouge, Louisiana; Lincoln, Nebraska; Reno, Nevada; Corvallis, Oregon; and Logan, Utah, with a proportionate reduction in departmental services.

(2) Clover investigations, $1,400. This decrease contemplates discontinuing cooperative sweet clover work at Urbana, Illinois, and reducing cooperative sweet clover work at Madison, Wisconsin.

(3) Soybean investigations, $751. This decrease contemplates discontinuing cooperative soybean work at Monetta, South Carolina, and reducing departmental services related to cooperative soybean work with several State agricultural experiment stations.

(4) Lespedeza, cowpea, and miscellaneous legume investigations, $1,300. This decrease contemplates discontinuing cooperative legume work at Monetta, South

Carolina, curtailing cooperative legume work with the North Carolina Agricultural Experiment Station, and reducing departmental services related to cooperative legume work with several State agricultural experiment stations.

(5) Grass investigations, $7,719. This decrease contemplates curtailment in cooperative grass and pasture work with the agricultural experiment stations at Manhattan, Kansas; Wooster, Ohio; and Woodward, Oklahoma, and in turf investigations at Beltsville, Maryland; and a reduction in departmental services related to cooperative grass work with most of the State agricultural experiment stations.

The reduction under this appropriation contemplates discontinuing the services of one agent, reducing labor and part-time assistants at several of the locations mentioned above, and the non-filling of two anticipated vacancies.

The estimated distribution of the reduction by States is as follows:

District of Columbia	$3,279
Illinois	900
Kansas	1,900
Louisiana	200
Maryland	1,560
Mississippi	1,330
Nebraska	500
Nevada	200
North Carolina	200
Ohio	500
Oklahoma	1,980
Oregon	400
South Carolina	351
Utah	200
Wisconsin	500
	14,000

WORK UNDER THIS APPROPRIATION

Objective: To increase returns to growers of soil-conserving crops used for hay, silage, pasture, range, and turf purposes, or as cover or green manure crops, (1) by reducing losses from drought, disease, cold, heat, and other hazards, (2) by increasing the yield of forage, and (3) by improving its quality for livestock feeding.

The problem and its significance: Grasses and legumes, the most important feed and soil-conserving crops, are grown on more than 600 million acres or about half of the total farm area of the United States. A conservative estimate of the total annual farm value of all forage crops would be upwards of $1,500,000,000.

Successful maintenance of the present forage acreage and its further extension in connection with land use adjustment of eroded and other problem areas calls for many modifications and improvements in cultural and management practices, and the development of varieties better adapted to meet these

special conditions and having greater resistance to cold, drought, and diseases.

General plan: The work consists primarily of field and laboratory experiments in cooperation with State agricultural experiment stations, Federal agencies, farmers, various crop improvement associations, and other similar groups. Some cooperative work is in progress in each of the 48 States, with full time employees located in 22 States.

Examples of progress and current program: The following examples of recent accomplishments under this appropriation are cited by crops to show progress on one or more aspects of the broader problems confronted. Other aspects of these problems are cited as indicating next logical steps to be taken in the research program.

Project 1. Alfalfa investigations

Wilt-resistant alfalfa: Emphasis in recent years has been on the bacterial wilt of alfalfa, a widespread disease which destroys stands in from 2 to 4 years in areas where alfalfa formerly would last 10 years or more. Upon discovery of this disease in 1925, it was necessary first to identify the causal organism and then to determine the possibilities of control by various seed treatments, sprays, and cultural methods. By 1933 it was apparent that disease-resistant strains afforded the greatest promise. Consequently in 1929, as a result of an expedition to Turkestan, disease-resistant strains were introduced. These strains were used as breeding material in developing resistant types with desirable hay and seed qualities.

During the last three years, in cooperative tests located in 40 States, a new strain, A-136, has shown much greater resistance to bacterial wilt than any of many other lines included in the tests. It is expected that this new alfalfa strain will be released commercially by the fall of 1943, if in further tests over wider areas it maintains its superiority in wilt resistance and at the same time proves to be otherwise suited to soil and climatic requirements in important alfalfa-producing areas.

Similar intricate procedures are involved in cooperative work in the humid areas of the United States on alfalfa yellowing, caused by the attack of a leafhopper, which not only reduces the yield but results in poor quality hay low in protein and in vitamin A potency. It has been possible to make only preliminary investigations of a little understood complex of diseases in irrigated areas of the Southwest, where alfalfa growers are complaining of excessive losses of stands.

Alfalfa seed production is confronted with complex problems entailing losses due to stripping of seed from the plants. The exact causes of stripping are not known, but appear to be associated with soil and climatic conditions as well as with certain insects, particularly the Lygus bug. Often many alfalfa flowers fail to "trip", a process believed to be necessary for satisfactory fertilization to occur, with the result that a poor seed set is obtained. Tripping of flowers is accelerated by the presence of certain harmless insects such as ground bees. Work is in progress to obtain a better under-

standing of the factors conducive to the setting of alfalfa seed in order to insure adequate supplies of seed to growers in all parts of the United States.

Project 2. Clover investigations

Improved strains of clover: For years farmers in the Middle West and in Eastern States have suffered serious losses from unsatisfactory cultural practices and from the use of seed of red clover susceptible to certain diseases and otherwise generally unadapted. In an attempt to combat these losses, two improved strains, Midland and Cumberland, superior in disease resistance and growth characters to the ordinary commercial red clover, have been increased and seed is now available in limited quantities. There is an urgent need for further improvement of red clover adapted to the widely variable environmental conditions of the United States and efforts to develop superior varieties are being continued.

The interest in sweet clover mainly as a pasture and soil improving crop has increased markedly in recent years. As has occurred with other crops, this rapidly expanding acreage has been accompanied with an increase in diseases and other problems related to its production and utilization. Two late maturing strains of sweet clover resistant to a serious root rot, and free from coumarin, a compound which affects the palatability of the herbage and is probably related to the toxic substance responsible for livestock losses, have been developed and are being used in furthering the improvement program. Seed of two new strains of sweet clover, Madrid and Spanish, superior for growing under drought conditions, have been released and are now being grown under certification in four States. These sweet clover varieties are especially adapted to the Great Plains. The possibilities of further improvement for different conditions and for increased palatability are readily apparent.

Subterranean clover, an introduction from Australia where it is regarded as a valuable forage plant, has been stimulated markedly in the Pacific Northwest during the past few years as a result of the discovery of better strains and of the increased growth to be obtained through the use of phosphate. These results suggest the possibility of developing varieties and cultural practices that may make this a valuable forage crop in other parts of the United States.

Strawberry clover, a rather recent introduction, is adapted to a wide range of conditions, having been successfully established in most of the Western States. While it will thrive on normal soil, it is of particular value on the considerable acreage of wet saline or alkaline soils in the irrigated districts of the West that heretofore have been almost valueless because of the inability of other palatable forage crops to thrive under such adverse conditions. Preliminary studies indicate the possibility of developing more productive and otherwise superior varieties.

Project 3. Soybean investigations

Superior varieties of soybeans: The yearly development and distribution of high yielding varieties with superior seed qualities for food and industrial

(oil and protein) purposes adapted to a wide range of soil and climatic conditions, and improved agricultural practices have been most important factors in the expansion of acreage and production of soybeans. More than 200 oil mills and food and industrial establishments use more than 70 percent of the constantly increasing annual production of seed for numerous feed, food, and industrial products.

There is an increasing interest in soybeans for foods, since they have a unique nutritive value because of the unusually high percent and character of protein and fat as well as important mineral elements. Forty-five vegetable varieties, superior in flavor and cooking qualities to the varieties used industrially, have been developed and placed in the trade. These varieties are rapidly increasing in acreage and production throughout the country, and are being used by an increasing number of canning companies, food manufacturers, and in home gardens.

With increased utilization of the soybean and its products, oil and oil meal, there is a demand from farming, industrial, and food interests for the development of more and better forage, oil, and food varieties to meet special needs and to extend the area of production. The improvement of varieties has become much more complex, involving not only selection but also hybridization, more specific composition studies, including the effect of environmental conditions on the composition of the seed. The shattering of seed has been a serious problem, especially in the Southern States. The development of non-shattering types would tend to greatly reduce the losses of seed in adverse seasons. Several selections and introductions have been found that show little to no shattering, and are being utilized in the improvement program.

Although soybeans were thought to be singularly free from serious diseases, a preliminary survey indicated that some diseases were seriously affecting seed production in many fields. Studies are being made of the various bacterial and fungus diseases, their causal organisms, and possible means of control. Breeding for disease resistance has been found an important factor, as studies indicate that varieties differ markedly in relative resistance to several of the more important diseases. Protective steps are of the utmost importance for a farm crop that now totals more than eleven million acres with a production of over 100,000,000 bushels of seed and an estimated value in 1941 of nearly $200,000,000.

Project 4. Lespedeza, cowpea, and miscellaneous legume investigations

The study of regional adaptation of annual lespedeza has resulted in varieties especially adapted to more northern conditions and in the extension of the acreage in the principal lespedeza regions from a few thousand acres in 1925 to 20,000,000 acres in 1941. A new disease identified as bacterial wilt has caused serious losses in a few places and attempts are being made to develop disease resistant strains and other control measures. Preliminary investigations have shown that in some areas where continuous cropping has resulted in declining yields applications of phosphate alone or in some instances in combination with lime and potash are highly beneficial. Lespedeza sericea, a more recent introduction, has proved to be especially well adapted to poor acid soils and an excellent plant for soil improvement. Its forage value is limited by the high tannin content. Factors influencing tannin

content are being studied and it is hoped that it will be possible to develop by selection and breeding a strain with little or no tannin. Such a plant would be widely used and very valuable in the South.

In the study of field pea diseases that have been serious in the South, it has been shown that such losses can be greatly reduced by not planting field peas oftener than once in three years on the same land. A more permanent solution of this problem is sought through the development of disease resistant varieties by selection and breeding.

Kudzu, a palatable and nutritious forage plant, is a comparatively recent introduction that has proved especially valuable in soil conservation and is extensively used in the Cotton Belt. Additional information on establishment, cultural requirements and utilization has been obtained. Experience has shown that Kudzu should not be grazed until well established, and even then not more than one animal should be carried per acre where continuously grazed.

Birdsfoot trefoil is a new crop that is proving of value in parts of the East and far West under certain poor soil conditions. One strain tested has proved much superior to others for hay and promises to be superior for pasture.

Alyceclover, a new summer forage crop for the South, is proving to be widely adapted and further information regarding cultural requirements has been obtained. Failure of the crop under certain soil conditions has been shown to be due to potash deficiency.

Project 5. Grass investigations

Improving grasses for hay and pasture: Emphasis in recent years has been placed on the development of grasses resistant to various diseases and better adapted to the variable environmental conditions of the United States.

A strain of Bahia grass that is much more cold resistant than the common type has been isolated thus making possible the use of this valuable southern pasture grass, adapted to soils of low fertility, much farther north than has been possible heretofore.

Selections of Pearl Millet, superior to the commercial type in yields and later maturity, have been obtained. In 1940 these selections produced a greater tonnage of silage than sorghum and made excellent fall aftermath growth at a time when good pasture was limited.

A strain of Sudan grass more resistant to destructive infestation of foliage diseases occurring frequently in the humid East and more vigorous than ordinary commercial Sudan grass is being increased.

Foundation seed stocks of Russian wild rye, a very promising drought resistant grass, have been developed and are being increased for the revegatation of abandoned farm lands in the Northern Great Plains and intermountain areas.

A selected strain of buffalo grass has given phenomenal seed yields under irrigation, indicating the possibility of making available a dependable supply of seed which heretofore has been obtained only with much difficulty and expense and even then in limited amounts.

In cooperation with the United States Golf Association, improved strains of turf grasses particularly Kentucky bluegrass, trivialis bluegrass, creeping red fescue, and bent grasses having desirable characteristics, including disease resistance, have been increased and propagated. Much valuable information has been obtained on more economical and effective use of fertilizers and chemical control of weeds.

In cooperation with State agricultural experiment stations and Federal agencies, 50 grass species involving two to ten strains of each species are being tested to determine their adaptation and value for hay and pasture at 53 nurseries in 35 States. Included in these tests are improved strains of native and introduced species of grasses of which seed is commercially available.

Burning of blue stem pastures in eastern Kansas in late April at the time the grass was resuming spring growth showed little or no injury to the pasture while those areas burned in early spring were severely injured by drought in August. Early spring grazing, which is a general practice, was also found to be detrimental. Stands of grass have been maintained in better condition by deferred grazing in spite of heavier use and at the end of the grazing season have a better cover to afford protection against wind and water erosion.

The grass improvement program is relatively new, but the progress that has been made during the past few years has indicated almost unlimited opportunities for developing by selection and breeding superior grasses for hay, pasture, erosion control, and turf purposes.

(i) FOREST PATHOLOGY

Appropriation Act, 1942, plus $1,835 supplemental for within-grade promotions ...	$256,835
Budget Estimate, 1943	243,460
Change from 1942:	
Decrease in working funds	- 15,000
Additional for within-grade promotions	+1,625
Net decrease	-13,375

PROJECT STATEMENT

Projects	1941	1942 (estimated)	1943 (estimated)	Increase or decrease
. Diseases of pine and other coniferous forest trees and forest products:				
(a) White pine blister rust investigations	$16,672	$16,532	$15,905	- $627
(b) Ponderosa pine disease investigations	12,172	13,768	11,681	- 2,087

PROJECT STATEMENT - Continued

Projects	1941	1942 (estimated)	1943 (estimated)	Increase or decrease
(c) Little leaf disease of southern pine, Investigations of	16,334	16,000	16,000	- -
(d) Southern pine diseases other than little leaf, Investigations of	7,587	8,357	8,357	- -
(e) Spruce, fir, cedar, and other conifer disease investigations	41,309	41,258	39,016	- 2,242
(f) Coniferous forest product disease investigations	14,088	13,545	13,545	- -
Total, Diseases of pine and other coniferous forest trees and forest products	108,162	109,460	104,504	- 4,956 (1)
2. Diseases of elm, chestnut, and other broadleaf trees:				
(a) Dutch elm disease investigations	37,750	37,750	30,011	- 7,739
(b) Elm diseases other than Dutch elm, Investigations of.	11,856	11,952	11,952	- -
(c) Chestnut disease investigations	19,438	19,500	18,900	- 600
(d) London plane disease investigations	5,700	5,700	5,700	- -
(e) Oak disease investigations.	11,095	11,095	11,095	- -
(f) Birch, beech and maple disease investigations	22,262	22,866	22,166	- 700
(g) Poplar, hickory, persimmon and other broadleaf disease investigations	25,221	26,677	26,252	- 425
(h) Cactus disease investigations	- -	10,000	9,420	- 580
Total, Diseases of elm, chestnut, and other broadleaf trees	133,322	145,540	135,496	-10,044 (2)
3. Net cost of within-grade promotions	- -	1,835	3,460	+1,625
Unobligated balance	3,516	- -	- -	- -
Total appropriation	245,000	256,835	243,460	-13,375

DECREASE

The decrease of $15,000 in working funds under this item for 1943 consists of:

(1) A decrease of $4,956 under Project 1, "Diseases of pine and other coniferous forest trees and forest products", estimated by work projects as shown in the project statement. This decrease contemplates curtailment of work in Wisconsin and California and curtailment of work in Washington, D. C.

(2) A decrease of $10,044 under Project 2, "Diseases of elm, chestnut, and other broadleaf trees", estimated by work projects as shown in the project statement. This decrease contemplates curtailment of Dutch elm disease investigations at Morristown, New Jersey; and curtailment of investigations on chestnut blight, persimmon wilt, and diseases of birch, beech, maple, and other hardwoods in Connecticut, Georgia and North Carolina; curtailment of cactus disease investigations in Arizona; and curtailment of departmental services.

Personnel curtailments contemplated under the decrease include discontinuing the services of an associate pathologist, a part-time assistant pathologist, and an agent, non-filling of an anticipated vacancy in a clerk-typist position, and a reduction in temporary employees in the field.

The estimated distribution of the decrease by States is as follows:

Arizona	$580	Georgia	$740
California	179	New Jersey	6,920
Connecticut	400	North Carolina	400
District of Columbia	2,191	Wisconsin	3,590
			15,000

CHANGE IN LANGUAGE

The estimates include proposed changes in the language of this item as follows (new language underscored, deleted matter enclosed with brackets):

> Forest pathology: For the investigation of diseases of forest and [ornamental] shade trees and [shrubs] forest products, including a study of the nature and habits of the parasitic [fungi causing the chestnut-tree bark disease, the white-pine blister rust, and other epidemic tree] fungi, bacteria, viruses, and other causes of such diseases, for the purpose of [discovering new] developing methods of control and [applying methods of] eradication [or control already discovered, and including $110,969 for investigations of diseases of forest trees and forest products, under section 3 of the Act approved May 22, 1928 (16 U.S.C. 581b), $255,000] and determining their application, $243,460.

These changes are proposed as a restatement of the previous language with a view to simplification. No additional authority is contemplated by the changes. The limitation previously carried for "investigations of diseases of forest trees and forest products under section 3 of the Act of May 22, 1928" is eliminated since the major part of the work under the item consists of such investigations.

WORK UNDER THIS APPROPRIATION

Objective: To develop practicable methods of decreasing or preventing losses from diseases affecting forest and shade trees and forest products, in order to decrease the costs and uncertainties of and increase returns from timber production, make wood give better service to the user, and preserve ornamental tree values in public parks, along city streets, and in private grounds.

The problem and its significance: Diseases, working constantly over the entire forest area, cause damage that is less conspicuous but in the aggregate is large than that due to fire. More than an eighth of the gross volume of the annual saw-timber cut, for example is culled because of heart rots. Diseases are important not only for the damage they do but because of the uncertainty they put into forestry enterprises. Better disease control and knowledge of how to forecast and avoid unnecessary losses are needed for public forestry and erosion-control programs and to aid farmers and other private owners in properly handling their woodlands.

Recent trends in forestry and recreation have increased the need for knowledge on the losses to be expected from disease and the means of reducing them. Selective logging methods, now being widely adopted, are likely to increase decay hazard unless this is especially guarded against; improvement operations in second growth stands may be profitless if disease aspects are neglected; the extensive forest and erosion control plantings are hampered by losses from disease; the higher sapwood content of lumber from second growth now being sold renders it less resistant to decay than that formerly available; disease epidemics destroy shade and ornamental trees, leave treeless city streets and reduce property values.

General plan: This work is directed almost wholly to the solution of current disease problems in forestry, and wood utilization, and in shade tree culture. Laboratory and controlled field tests are conducted in cooperation with the Forest Service, the Soil Conservation Service, the National Park Service, State Experiment Stations, municipalities, and nurserymen.

Examples of progress and current program: The following examples of recent accomplishments under this appropriation are cited to show progress on one or more aspects of the broader problems confronted. Other aspects of these problems are cited as indicating next logical steps to be taken in the research program.

Project 1. Diseases of pine and other coniferous forest trees and forest products

White pine blister rust: It has been demonstrated that because of differences in weather and in the reaction of local species the control of rust is a different problem at high elevations in the West and in the sugar pine region of California than in the parts of the country in which the

disease has been studied previously. Preliminary studies show that in these regions the pine species are extraordinarily susceptible but the ribes (currants and gooseberries) require unusual combinations of weather to transmit the disease to pine. Experimental plots for the detailed study of these factors have been established. Here many ribes species are being tested, representative of the susceptible flora along the Sierras and the Rocky Mountains, aimed to determine in advance of the southern march of the rust, what species are dangerous and should be eradicated thoroughly and how far from the pines. A difference of a few hundred feet makes an enormous difference in the cost of control.

Based on analysis of Pacific Coast upper air movement and rainfall, accurate predictions have been made for 4 years as to whether the season was favorable for southward spread of the rust, thus permitting the adjustment of scouting and control operations. The high susceptibility of white bark pine has been confirmed and experiments on canker removal to preserve stands of unusually high recreational and watershed value, such as on Mt. Hood and in the National parks, are in progress. The program includes the development of resistant or immune varieties of the white pines and of cultivated currants in the East and West.

Little-leaf disease of southern pines: Extensive surveys run in Alabama in 1941 indicated a tree loss of 19 to 45 percent in shortleaf pine. A loss of 3 1/2 to 7 1/2 million dollars was estimated for the State.

Cooperative research with the States was instituted in 1940. Principal headquarters are located at Auburn, Ala., Athens, Ga., and Asheville, N. C. The investigations are being developed along the following lines: Symptoms; damage and progress of the disease; soil factors, including experiments with fertilizers and minor elements, to determine importance of chemical deficiencies; injection of curative chemicals; climatic factors; range of susceptibility among pine species; and possible infective agents.

Nursery diseases: In forest and erosion control nurseries in the South, noteworthy decreases have been secured in the damping-off disease of the highly susceptible longleaf pine by the simple use of sawdust as a seedbed cover. The southern pine stem rust and destructive diseases of spruce and red cedar in the East and Midwest are now being given special attention.

Decays and stains in forest products: In the study of the fungi that cause sap stain in southern lumber, it was found that scraps of green wood are a source of infection in lumber yards, but that old weathered wood does not need to be removed in yard sanitation.

Studies have been undertaken on the defects of wood used in military training planes, in defense housing, and in the construction of mine sweepers. In airplane woods, the purpose is mainly to improve the methods employed by inspectors for detecting incipient decay infection; in housing, to determine for structures placed close to the ground what amount of subfloor ventilation and other precautions are needed to prevent costly decay in defense buildings; and in boats, to determine what modification of peacetime standards can be made without inviting early decay. Whenever possible

to make temporary reduction of work on other projects without permanent loss, investigations are being directed to these defense problems.

Project 2. Diseases of elm, chestnut, and other broadleaf trees

Elm diseases: The origin, history, and cause of Dutch elm disease in the United States have been reported previously. Recent work at the Dutch Elm Disease Laboratory, Morristown, New Jersey, has demonstrated that (1) some infected elms recover from the Dutch elm disease through walling off of the causal fungus in the wood, (2) the disease can and does cross the ocean in elm slats used in crates for shipping European pottery, and (3) heat treatments, as thus far applied, cannot be relied upon to inactivate the fungus in infected nursery stock. Current and new researches are being definitely organized along lines designed to aid the suppressive program by developing curative treatments and resistant trees. These control methods are applicable also to phloem necrosis described below. The search for chemicals harmless to the elm but toxic to the parasites when injected into the tree gives much promise for saving valuable trees. Occasional resistant American elms have been found and these will form the basis for selection and propagation of elm strains resistant to both diseases. Other elm species found by experimentation to be resistant are being assembled for breeding with the American elm. Crosses thus produced will be selected for resistance and graded for the desirable vase form and other qualitites that have made the American elm one of our most valued shade trees.

Phloem necrosis, a highly contagious disease of American elm, has spread alarmingly over a considerable portion of the Ohio River Valley and has appeared recently in Mississippi. In 1941, more than 5,000 elm trees died of this disease in Columbus, Ohio. Property values were lowered by loss of the trees, and the expense of removing the elms now dead or dying in this one city will exceed $150,000. The research to date has shown that the disease is caused by an infective virus. Technical points, such as symptom manifestation, incubation period, rate of movement of the virus in the tree, and the tissues attacked, have been determined. Susceptibility of other elms and of related plants that may be sources of infection are being studied. The means of natural spread has not been determined, but cooperative research on insect carriers is now well organized and should eventually solve this important aspect of the problem. At Columbus, Ohio, by cooperation with the Ohio Experiment Station and the U. S. Bureau of Entomology and Plant Quarantine, a laboratory and an experimental nursery of 15 acres are maintained and devoted primarily to work on this disease.

Chestnut disease investigations: The cutting off of tannin imports in the present war emergency focuses attention upon all potential domestic sources of tannin. Among these are the Asiatic chestnuts. Strains resistant to the blight which destroyed the American chestnut, a principal source of tannin, are being developed. Some of these strains offer promise of being valuable for their tannin content. Work with these strains is continuing with a view to producing, by further selection or hybridization, a high tannin-bearing, blight-resistant type.

Growth of Asiatic chestnuts in the older forest plantings in the eastern States indicates that selected disease-resistnat strains on good sites will produce small poles, one of the most valuable former products of the American chestnut. The eradication of the blight from the Pacific Coast chestnut orchards, in cooperation with State authorities, continues to give promise of ultimate complete success; the Oregon and Washington infections have shown no recurrence in the past 6 years. The number of first and second generation hybrids of Oriental and American chestnuts and chinquapins now made exceeds 5,000. Different hybrids give promise for wild life, forest, and orchard use.

(j) FRUIT AND VEGETABLE CROPS AND DISEASES

Appropriation Act, 1942, plus $7,865 supplemental for within-grade promotions ...	$1,449,227
Budget Estimate, 1943	1,368,410
Change from 1942:	
Reduction in working funds	-91,362
Additional for within-grade promotions	+10,545
Net decrease	-80,817

PROJECT STATEMENT

Projects	1941	1942 (estimated)	1943 (estimated)	Increase or decrease
1. Deciduous fruit investigations	$295,408	$297,698	$278,943	-$18,755(1)
2. Citrus, avocado, and other subtropical fruit investigations	111,726	113,303	106,165	- 7,138(2)
3. Nut investigations	245,468	246,824	231,274	- 15,550(3)
4. Vegetable investigations	280,730	287,934	269,944	- 17,990(4)
5. Floricultural and ornamental horticultural plant investigations	68,423	78,896	68,492	- 10,404(5)
6. Nursery stock and farm windbreak investigations	65,559	65,955	63,100	- 2,855(6)
7. Potato investigations	98,375	99,228	93,603	- 5,625(7)
8. Methods of handling, transportation and storage, and market diseases of fruits, vegetables, and flowers	172,865	174,152	163,181	- 10,971(8)
9. Experimental greenhouse maintenance	76,989	77,372	75,298	- 2,074(9)
10. Net cost of within-grade promotions	- -	7,865	18,410	+10,545
Unobligated balance	10,819	- -	- -	- -
Total appropriation	1,426,362	1,449,227	1,368,410	-80,817

DECREASE

The decrease of $91,362 in working funds under this item for 1943 consists of the following reductions:

(1) Deciduous fruit investigations, $18,755. This decrease contemplates discontinuing a field laboratory for investigations on the spraying of tree fruits for disease control at Vincennes, Indiana, and a laboratory for investigations of strawberry diseases at Willard, North Carolina; curtailment in tree fruit breeding in California, and in investigations on production of high quality fruits conducted at Beltsville, Maryland; investigations on virus diseases of fruits conducted in California, Texas, and Washington; breeding of hardy fruits at Cheyenne, Wyoming; and grape production and breeding investigations at Fresno, California, and Beltsville, Maryland.

(2) Citrus, avocado, and other subtropical fruit investigations, $7,138. This decrease contemplates curtailment of work on breeding, diseases, and quality of subtropical fruits conducted at Orlando, Florida; and curtailment of work on production of dates and irrigation of citrus fruits in California.

(3) Nut investigations, $15,550. This decrease contemplates discontinuing the pecan field station at Philema, Georgia; curtailment of work on disease investigations of pecans at Albany, Georgia; pecan production investigations at Brownwood, Texas; and on factors influencing tung production conducted at Fairhope, Alabama, Gainesville, Florida, Bogalusa, Louisiana, and Beltsville, Maryland.

(4) Vegetable investigations, $17,990. This decrease contemplates curtailment in the work on factors influencing vegetable production in the Eastern States at Beltsville, Maryland; on diseases of southern-grown tomato plants at Tifton, Georgia, and New Brunswick, New Jersey; peanut production investigations at Experiment, Georgia; breeding of lettuce and other vegetable crops at Torrey Pines, California; cabbage breeding and disease investigations at Madison, Wisconsin; breeding of hardy vegetable crops for the Great Plains area at Cheyenne, Wyoming; tomato disease investigations at Logan, Utah; sweetpotato investigations at Baton Rouge, Louisiana; and onion breeding at Davis, California, and Ames, Iowa.

(5) Floricultural and ornamental horticultural plant investigations, $10,404. This decrease contemplates curtailment of work on the development of American sources for bulbs and breeding and disease investigations of lilies, chrysanthemums, flowering shrubs, including azaleas and rhododendrons, and related work, at Beltsville, Maryland, Baton Rouge, Louisiana, Babylon, New York, Corvallis, Oregon, Charleston, South Carolina, and Cheyenne, Wyoming.

(6) Nursery stock and farm windbreak investigations, $2,855. This decrease contemplates curtailment of work on crown-gall as affecting fruit and ornamental plants at Beltsville, Maryland, and of work on testing and developing suitable windbreak plants and the handling of windbreaks in the central Great Plains at Cheyenne, Wyoming.

(7) Potato investigations, $5,625. This decrease contemplates curtailment in potato breeding investigations at Presque Isle, Maine, and at Beltsville, Maryland.

(8) Methods of handling, transportation and storage, and market diseases of fruits, vegetables, and flowers, Investigations of, $10,971. This decrease contemplates curtailment of work on market diseases of apples, pears and citrus fruits at Beltsville, Maryland, and Orlando, Florida; and curtailment of investigations on transportation of perishable fruits and vegetables from various parts of the country to market centers.

(9) Experimental greenhouse maintenance, $2,074. This decrease contemplates a reduction in the staff operating the greenhouses at Beltsville, Maryland, with curtailment in investigational work under way in the greenhouses.

Personnel reductions contemplated by the decrease in this appropriation are shown in the following tabulation, the first column of which indicates personnel to be dropped and the second column anticipated vacancies that will not be filled:

1 P-3 Associate pathologist	1 P-6 Principal pathologist
1 P-1 Junior pomologist	1 P-5 Senior pathologist
1 SP-7 Principal scientific aid	2 P-4 Horticulturist
1 SP-5 Scientific aid	1 P-3 Associate pathologist
1 SP-3 Student aid	1 P-3 Associate physiologist
1 CAF-3 Assistant clerk	1 P-1 Junior pomologist
1 CAF-3 Assistant clerk-stenographer	1 SP-7 Principal mechanic
1 CAF-2 Junior clerk-stenographer	1 SP-6 Gardener
Part-time assistants and seasonal labor	1 CAF-7 Junior admin. asst.
	1 CAF-1 Under clerk
	2 Agents

The estimated distribution of the decrease by States is as follows:

Alabama	$4,000	Mississippi	$200
California	4,758	New Jersey	1,150
Colorado	400	New York	1,500
Connecticut	300	North Carolina	3,700
Florida	6,034	Oregon	1,640
Georgia	7,200	South Carolina	2,040
Indiana	3,150	Texas	2,800
Iowa	100	Utah	950
Louisiana	3,750	Virginia	300
Maine	3,000	Washington	500
Maryland	39,165	Wisconsin	300
Massachusetts	100	Wyoming	4,325
			91,362

WORK UNDER THIS APPROPRIATION

Objective: To increase returns to growers of fruit, vegetable, potato, nut and ornamental crops and to insure a satisfactory supply of these important food crops essential to the diet of the people through (1) developing varieties by breeding that are more resistant to diseases and adverse climatic conditions and that are of superior quality, (2) developing improved practices of orchard, field and greenhouse management including fertilization, irrigation, pruning, spraying, cultivation, (3) developing knowledge of diseases and how they may be controlled including new fungicide materials for combating them, and (4) developing the best methods of handling and storing the harvested products, most of which are highly perishable.

The problem and its significance: These crops are the great health protectors in human diet as well as highly important staple food sources. The farm value is indicated in the following tabulation:

	Farm Value 1939
*Fruit crops	$421,532,000
*Truck crops	256,873,000
*Potatoes	250,199,000
*Nut crops	20,575,000
**Horticultural specialties, including nursery products, and flowers, bulbs, and plants grown in the open and under glass	129,500,000

*Figures taken or compiled from Agricultural Statistics, 1940.
**From 1939 Census.

Any serious reduction in the quality or quantity of these crops as a result of disease epidemics, faulty handling, unfavorable climatic conditions or other causes would be extremely serious, not only to the farmers producing them, but to the health and economic welfare of the whole people. The worth of ornamental crops in improving home surroundings both within and without the residences cannot be evaluated in dollars and cents. Unquestionably, they contribute tremendously to the stability and morale of American home life. Continuous research to develop improved varieties, production methods, and handling and storage methods for these crops is essential to the continued sound condition of the industry.

General plan: The work consists primarily of field and laboratory experiments, largely cooperative with State Agricultural experiment stations, other Federal agencies, and producers of horticultural crops. National headquarters are at the U. S. Horticultural Station, Beltsville, Maryland, from which point direction is given to personnel

located in the States of Alabama, Arizona, Arkansas, California, Colorado, Florida, Georgia, Illinois, Indiana, Iowa, Louisiana, Maine, Maryland, Massachusetts, Minnesota, Mississippi, Missouri, New Jersey, New York, North Carolina, Oregon, South Carolina, Texas, Utah, Washington, Wisconsin, and Wyoming.

Examples of progress and current program: The following examples of recent accomplishments under this appropriation are cited to show progress in one or more aspects of the broader problems confronted. They are illustrations of the ways in which the problems are being attacked and examples of results secured. No attempt is made to give a complete summary of the several hundred investigations that are under way.

Project 1. Deciduous fruit investigations

Leaf composition an indicator of fertilizer need of apple and peach trees: With a decrease in the supplies of farm manure and greater dependence on commercial fertilizers, the question whether particular fertilizer elements are needed by trees has become increasingly important. A combination of laboratory and field work has given a basis for determining quickly by laboratory analyses whether or not trees in a particular orchard or district will respond to applications of potassium fertilizers. Additional work now being developed is designed to give a similar background for additional elements including calcium and phosphorous.

Hormone sprays: Spraying with hormones or growth substances to prevent preharvest drop of apples, an important discovery of this Bureau, is being studied further to determine how growers may best use these sprays. Growers applied these sprays on 25,000 acres of apples in 1940 and it is estimated that in 1941 they used them on 75,000 acres. In California the sprays have been successfully used also on apricots and pears.

Bearing habits of apple trees changed by chemical sprays: Experiments made during the past two years have demonstrated that it is possible to change biennial-bearing apple trees to annual bearers, by chemical sprays that reduce the excessively large crop of the "on" year. Additional work is under way to determine practical applications.

Promising new varieties of tree fruits: Breeding investigations are under way, in cooperation with a number of States, to develop high-quality hardy varieties of apples, pears, peaches, and other fruits. Promising high-quality, early-ripening varieties of peach have been developed at the Department field station at Fort Valley, Georgia, and in California several canning cling varieties have been introduced. Development of high-quality pears resistant to

fire blight, a destructive disease, is progressing and promises eventual success.

Better small fruits: Breeding work with strawberries, raspberries, blackberries, and blueberries has yielded many varieties that have taken high rank in commercial and home plantings. During the past year four new strawberry varieties were named and introduced. Breeding of varieties for resistance to root and foliage diseases shows great promise. The rapid growth of the blueberry industry adds importance to diseases now being investigated for the first time.

Better spray materials: For almost a half century copper sprays, and more recently sulphur sprays, have been depended upon for control of fungus diseases with orchard, truck, and ornamental crops. While effective fungicides, the materials frequently cause heavy damage to the plants on which they are applied. In the search for new fungicide materials, a systematic testing of a great number of organic compounds or of combinations of organic and inorganic materials is being carried out.

Of the several hundred materials tested to date, the following chemicals or chemical compounds have shown particular promise: Phenothiazine, the thiuram disulphides, diphenylamine derivatives, and the thiocarbonates. These have given at least some degree of control of such serious diseases as apple scab, peach brown rot, and cherry leaf spot, and may eventually come into practical use. While in the present stage none of these organic materials can be recommended for commercial spray practice, it is believed probable that with further development of the test, including methods of application, some of these materials will become valuable fungicides, possibly less injurious to the sprayed plants than those that are now available.

Project 2. Citrus, avocado, and other subtropical fruit investigations

Two citrus hybrids fruiting for the first time in Florida are very promising. A seedless orange selection seems to be particularly valuable for early spring maturity in desert areas of the Southwest. Extensive breeding work is in progress to develop superior varieties of citrus fruits, avocados, mangoes, pineapples and papayas that will be resistant to destructive diseases.

The set of fruit of Washington Navel orange and of Marsh grapefruit was greatly increased under conditions in the Southwest by the use of pollen from a seedy variety of grapefruit.

Tests are being made of the possible effectiveness of growth regulating chemicals on rooting, flower initiation, fruit setting, and prevention of mature fruit dropping for citrus and other subtropical fruits.

The treatment of pineapple plantings with minute doses of ethylene gas under cloth covers has induced early blooming and maturing of fruit in Florida, thereby making possible the marketing of the fruit at a more favorable time.

Blacknose defect in dates can be minimized by reducing the frequency of irrigation during the early period of most rapid fruit enlargement.

Hubam clover has proved superior to other cover crops for date palm orchards. Soil improvement practices have been worked out for improving the penetration of irrigation water in "tight" soils.

Soil moisture and aeration conditions favorable for avocado root functioning are being determined.

Project 3. Nut investigations

Tung: Methods for the satisfactory asexual propagation of tung trees have been worked out, using an inverted T-bud. All trials of grafting resulted in failure since satisfactory unions between stocks and scion would not take place.

Evidence available indicates that the planting of clones in commercial tung orchards would result in the greatest increase in production of tung fruit on an acre basis that can be effected by any known means. In the fall of 1941, 50,000 trees were budded for varietal tests and for experimental orchards in which the variability due to seedlings may be eliminated through the use of these clones. Following the leadership of the Bureau, commercial growers have budded 175,000 trees.

Seed stratification, or the use of agents that render the shell permeable to water, has been found to reduce greatly the time required for the germination of tung seeds in seed beds. Untreated seeds germinate slowly and unevenly. Early and uniform germination is necessary in order that the seedlings may be of sufficient size and maturity by August, when budding should commence.

Selection work has resulted in the discovery of tung trees that flower several days later than all other seedling trees so far observed. These trees have borne full crops for the past four years although frosts in 1939 and 1940 reduced the crops of other trees.

Results clearly indicate that the tung tree is very sensitive to an excess or deficiency of mineral elements used in their

nutrition. Work on fertilizer requirements of tung is being vigorously pushed.

Pecans, walnuts, and chestnuts: Pecan soil management practices are found to greatly affect yield of pecans. Pecan orchards receiving clean cultivation during the summer with a winter leguminous cover crop have made a net return per acre of $21.67 as compared to $6.75 for similar orchards in Bermuda grass sod. Even on fertile soils of the Red River Valley of Louisiana proper pecan tree fertilization has resulted in increased yield of nuts at a lower cost of production than was obtained from similar unfertilized trees. Experiments are being conducted to determine the fertilizer elements, and rate, method, and time of application for different soils.

Foliar analysis of pecan leaves has resulted in the establishment of levels of phosphorus required for optimum growth and production. This level has been found to be .15 percent on a dry weight basis.

The proper pruning of pecan trees has resulted in the retention of the foliage in a healthy condition later in the fall than has occurred from the control of diseases causing premature defoliation, thus indicating that the increased supply of moisture and nitrogen to pecan leaves, resulting from reducing the top, is an important factor.

Orchard sanitation has been found to be effective in reducing the incidence of fungus diseases attacking both pecan leaves and nuts. Needed additional information is being developed on sanitation practices.

It has been found that most of the soils devoted to nut growing (walnuts and filberts) in the Pacific Northwest are deficient in boron, especially in the subsoils. It is believed that this element may be readily supplied in the form of borax or boric acid, or by the addition of organic matter from outside sources.

Improvement in the degree of success in the propagation of chestnuts by grafting has been made. Selections of the Chinese chestnut have been made which bear nuts of larger size and superior quality than those of our native American chestnut that has been destroyed by the chestnut blight disease.

Project 4. Vegetable investigations

Pan America tomato: The release of the Pan America variety of tomato in the fall of 1940 represents the culmination of probably one of the most important and most intensive pieces of work conducted by the Bureau in the last few years. This variety is similar to Marglobe, the most important single variety of tomato in this country, in its general horticultural characteristics, but has the advantage of being practically immune to fusarium wilt. Marglobe, one of the parents of Pan America, has only an intermediate or partial resistance. The

other parent was a particular fusarium-immune strain of Lycopersicum pimpinellifolium, the currant tomato, sent to us by a scientist in Peru through our Division of Plant Exploration and Introduction. The original inter-species cross was made in 1936. About 50,000 plants of the third back-cross were grown in 1938 from which about 40 satisfactory appearing, large-fruited segregates were obtained. Progeny of these were promptly tested against wilt in the greenhouse by newly developed, standard techniques, and all but four eliminated because of measurable susceptibility. The progenies of one of these four were then grown on a large scale and further selected to fix the horticultural type and disease resistance. Quantities of seed were released in the fall of 1940 sufficient to permit this variety appearing in the trade in 1942. The next step is to put this resistance into other good commercial sorts as was done in developing the Pan America.

Another need in the tomato field is the development of varieties resistant to the diseases that cause loss of foliage. Loss of foliage terminates fruit production and usually results in sun burning of the fruit already formed. A project cooperative with the Regional Vegetable Breeding Laboratory at Charleston is under way to breed tomatoes for resistance to defoliation diseases which now cause losses even greater than those due to wilt.

Improving sweetpotato varieties: In cooperation with Southern States thousands of new sweetpotato seedlings are being produced, grown, and studied for adaptability to manufacture and feeding purposes as well as for market. First reports will soon be published on the best of these which appear superior in starch content and yield to any named varieties.

Other investigations have contributed to extending the period of starch plant operation through demonstrating practicability of delayed harvest of sweetpotatoes in the lower South.

Improved production of vegetable plants for shipment: Investigations of diseases and methods of production of vegetable plants in the South for shipment northward (about 7500 acres of plant beds in Georgia alone) have enabled growers to increase the number of plants harvested per acre about 50 percent, and have improved the quality and decreased losses of such plants after shipping to northern growers. Many problems remain to be solved, however.

Better beans and squash: A recently introduced, early, hardy, productive lima bean of higher quality than the old standard sort is now in widespread cultivation. Recent studies of a disease-resistant snap bean, developed a few years ago for canning, show it to be remarkably adapted to local and home garden culture in the South in summer when other varieties fail. An improved strain of curly-top resistant squash has been released to the trade. It is probable that curly-top resistant snap beans from promising lines bred in Oregon can be released to the trade in another year or two.

Conserving vegetable seeds: Studies recently have been made that show safe maximum temperatures and humidities for transporting and storing seeds of 15 of the most important vegetables. With stocks low and with terrific demands from governments America is trying to aid, it is important to develop methods to conserve these short-lived, expensive, seeds.

Breeding improved onions: In the onion-breeding program special consideration has been given to the development of varieties that are better adapted and are resistant to insects and diseases. A new variety named the San Joaquin has just been released that is especially well adapted to certain districts of the Southwest where the Bermuda types have been grown. At Shafter, Calif., in 1940, this new variety produced 1,713 50-pound sacks of onions to the acre, as compared with 595 for Crystal Wax, which is the variety commonly grown there. In 1941 San Joaquin produced 850 50-pound sacks, as compared with 332 for Crystal Wax. Progress is also being made in the development of thrips-resistant varieties for practically all of the important onion districts of the United States. A variety resistant to downy mildew, especially adapted to certain districts of the West Coast where mildew is very severe, should be ready for release in a year or two. Progress also is being made in the development of smudge- and smut-resistant varieties for the North, and purple-blotch resistant varieties for the South and West.

Project 5. Floricultural and ornamental horticultural plant investigations and Project 9. Experimental greenhouse maintenance.

American Easter lily bulbs: Several new Easter lilies have been produced by breeding and it has been shown that bulbs grown in the southern part of the country can be dug and by proper treatment in storage and handling can be forced for the Thanksgiving and Christmas markets. Until this work was done, the only lilies available were Japanese stocks, the bulbs of which had been carried over one year in cold storage. This treatment weakens them so much that they usually do not average two flowers per plant. The southern-grown American bulbs produced and handled, as worked out in these investigations, develop plants having four to six flowers.

It has also been found that the new Easter lilies can be multiplied very rapidly through the use of plant auxins, or hormones. This work is of great importance because of the present uncertainty of the foreign sources of lily bulbs which have previously supplied American markets. Further development of these new lilies and methods of propagating them and growing and handling the bulbs remain to be perfected. When this is done, American florists will be independent of foreign sources of supply and a new noncompetitive cash crop will be available for farmers in certain sections of the South.

Azalea flower spot disease: Intensive investigations were continued to develop a practical control for the flower spot disease of azaleas in nurseries and gardens in Southern States. Soil treatments with cyanamid to destroy the fungus fruiting bodies give a promising lead.

New varieties and better flower production methods: Methods for reducing the amount of electricity needed when greenhouse chrysanthemums are grown under lights, to delay flowering and thus gain a favorable market, have been studied. It has been demonstrated that as little as 30 minutes of light at midnight will delay blossoming for a period of 6 to 8 weeks.

New varieties of roses, carnations, and chrysanthemums have been developed by breeding and are being compared with the best commercial varieties now available. A superior variety of carnation has recently been released for commercial use.

Virus diseases of Easter lilies and hardy lilies have received intensive study, looking toward the development of more effective control measures for these destructive diseases in expanding domestic culture.

Greenhouse experiments in the nutrition of flower crops such as lilies, narcissus, bulbous iris, and tulips are being conducted to determine the best fertilizer practices that will produce superior crops under glass.

Project 6. Nursery stock and farm windbreak investigations

Selection of promising seedling rootstocks for apples indicates that apple stocks formerly imported may be grown satisfactorily from seeds of varieties grown in this country. Selections of stocks for resistance to root-rot and crown gall are being made. Nematode-resistant rootstocks for peaches and grapes that will insure longer life for these fruits in the South and in other regions having nematode-infested soils are being developed.

In breeding investigations to develop hardy types of tree and bush fruits adapted to Central Great Plains conditions, additional hardy parental material of apricot, pear, and apple, has been collected from old Spanish and Indian plantings at high altitudes. Several native plum selections are proving to be hardy and to have good fruit characters. Among the raspberry, strawberry, and grape seedlings are some that are very promising for vigor, hardiness, fruit quality, and disease resistance.

Project 7. Potato investigations

New potato breeding method: Investigations conducted in the greenhouse at Beltsville, Maryland, and at Greeley, Colorado, to determine the environment best suited for flowering and seed setting demonstrated that the length of the period of daylight was the most important factor for most varieties. A daylight period of 16 to 17 hours was found to be sufficient. These long days are secured by supplementing the natural day with artificial light. A cool temperature is also necessary but this can be controlled by crossing the crop in the greenhouse during late winter and early spring.

As a result of these experiments, practically all of the potato hybridizing work is now being conducted in the greenhouse where the length of daylight and other environmental conditions can be controlled. This year more hybrid seed has been secured than ever before which makes it possible to expand the testing work in cooperating States.

New potato varieties: New varieties that show promise are: In Colorado a variety better adapted to growing conditions in that State; in Ohio one more promising than the old commercial varieties; in Maryland one resistant to leafhoppers, fleabeetles, and late blight; in New York State one with a medium-long tuber, promising as a baker; in California a variety with long-tuber type resistant to a number of virus diseases; in Michigan a late scab-resistant variety showing high yields; and in Iowa early scab-resistant varieties urgently needed for some of the muck lands, not only in Iowa but also in other States.

Potato soil-fertility and fertilizer work: Special attention is being paid to methods of maintaining soil organic matter by means of green manure crops and to methods of utilizing fertilizers economically. In Maine and Pennsylvania, new phosphorus compounds are comparing favorably with standard phosphorus carriers; concentrated or high-analysis fertilizers are giving high yields; and side placement of fertilizer is giving excellent results. Certain minor elements, chiefly magnesium, are being found essential in potato fertilizers. Studies are being continued on source and rate of potash in potato fertilizers as influencing yield and quality. Rate and kind of fertilizer has economic implications; for instance, it is being shown that the inorganic nitrogen portion in potato fertilizer may be conserved somewhat if necessary for use in defense. The interaction of seed spacing and rate of fertilizer application show that some control over size of tubers for seed-stock purposes is practicable.

Project 8. Methods of handling, transportation and storage, etc.

Carbon dioxide as supplement to refrigeration in fruit transportation: As a result of laboratory tests, followed by small-scale shipping tests and ultimately by full carload shipping tests, it has been established that the use of carbon dioxide to supplement refrigeration is of much value for the transportation of sweet cherries from the Pacific Coast to Eastern markets. As a direct outgrowth of this work, shippers in the Pacific Northwest have made increasing use of the carbon dioxide method during the past three years and now it is used practically 100 percent on sweet cherry shipments. The gas-treated cherries ripen less in transit and have less decay than those shipped under ordinary refrigeration and outsold the latter fruit by about 25¢ a box. The gas treatment costs $30.00 per car but shippers state that their increased returns from its use averaged about $400.00 per car. Approximately 1,800 cars per year of sweet cherries are shipped from Western States to Eastern markets. Thus a gain of $370.00 per car applied to the shipments from these Western States would mean a net profit to the sweet cherry industry attributable to this research of about $666,000.00 per year.

With peaches shipped from Georgia, the gas treatment has been found to retard ripening and to keep the fruit firmer. Under some conditions the gas treatment has also reduced losses from decay. It has not been established, however, that the additional cost of the gas treatment is generally justified with Georgia peaches.

Laboratory studies are being continued covering a wide range of fruits and vegetables. Tests conducted to date indicate that the treatment can be employed successfully with plums and pears but carlot tests have not yet been made. Further experimental work is also necessary to develop economical and efficient ways of applying the gas treatment. Since the ordinary railway refrigeration car is not gas-tight, there is consequently a wastage of gas with correspondingly higher cost of the treatment.

Possible savings in transportation costs: By use of fans driven from the wheels of the car which produce a forced circulation of the air from the ice over and through the load, it has been found that oranges from California can be carried to Atlantic seaboard markets just as satisfactorily in 630 box loads as in the usual 420 box load, in which natural air circulation is depended upon. This should result in releasing a large number of cars for other use and reduce the deadweight non-pay load that the railroads have to haul and, logically, should also result in lowered transportation costs to shippers. These studies are also being carried on with citrus fruit from Florida to northern markets and with apples from the Pacific Northwest to eastern markets.

Handling and transportation of new potatoes: Decay of new potatoes in transit often causes 25% or more loss. Investigations are under way with potatoes from Florida, Mississippi, Louisiana, and other Southern States, and from California and Nebraska. They involve studies on methods of handling from the time of digging, including effect of exposure to sun in the field, methods of washing, packaging, precooling or other conditioning and methods of shipping, i.e., under ventilation or refrigeration. Results thus far indicate that under certain climatic conditions drying the tubers before shipment and shipping under ventilation is cheapest and most effective. This is true in Southern Florida where the potatoes are shipped during relatively cool weather but farther north as well as in Nebraska and California where the early potatoes are dug during extremely hot weather, precooling and shipping under refrigeration rather than ventilation seems to give best results.

Other investigations are being made on problems of shipping and ripening of pears and plums from the Pacific Coast, maturity and coloring or degreening of citrus fruits, tomatoes and other horticultural products and on storage problems in general as well as on the nature, cause, and control of diseases affecting these products after harvest, which cause heavy losses to producers and higher prices as well as poorer quality for consumers.

(k) IRRIGATION AGRICULTURE

Appropriation Act, 1942, plus $700 supplemental for within-grade promotions	$141,200
Budget Estimate, 1943	142,220
Change from 1942:	
Additional for within-grade promotions	1,020

PROJECT STATEMENT

Projects	1941	1942 (estimated)	1943 (estimated)	Increase or decrease
1. Investigations of crop production on irrigable lands, the quality of irrigation water, and its use by crop plants:				
(a) Crop rotation and cultural investigations under irrigation	$82,533	$83,176	$83,176	
(b) Quality of irrigation and drainage water	30,097	30,597	30,597	
(c) Water requirements of crop plants	26,526	26,727	26,727	
2. Net cost of within-grade promotions		700	1,720	+1,020
Unobligated balance	1,344	- -	- -	- -
Total appropriation	140,500	141,200	142,220	+1,020

WORK UNDER THIS APPROPRIATION

Objective: To insure a successful irrigated agriculture by determining (a) the best varieties of crops, crop rotations, and fertilization and irrigation practices; (b) the effects on the growth of crop plants of salt constituents in irrigation and drainage waters and in the soil solution, and the movement of these salts in irrigated lands; and (c) the quantities of irrigation water required by different crops on different soils.

The problem and its significance: The irrigated lands of the Western United States comprise approximately 20 million acres. These lands occur in isolated areas contiguous to streams in the arid region. They are surrounded by extensive areas of semi-arid land used for dry farming, and for grazing. The agricultural enterprises of the irrigated lands and of the surrounding semi-arid lands are mutually interdependent since the irrigated lands are sources of feed crops to supplement the ranges and, conversely, the use made of the forests and ranges directly affects the water supply for irrigation.

Because the costs of irrigation farming are relatively high, due to the service costs of irrigation water and labor of applying it to the land, the crop yields most also be relatively large. Furthermore, the costs of the construction of works for the storage and distribution of irrigation water require a long period of liquidation so that permanency and sustained productivity of irrigated land are essential to economic success.

Approximately one-half of the total supply of irrigation water in the western United States contains so much dissolved salts as to be potentially injurious to the irrigated land unless adequate measures are taken to provide root zone leaching and sub-soil drainage. Dissolved salts occur naturally in irrigation waters. Most of the salts obtained in the irrigation water are not absorbed by plants, but remain dissolved in the soil solution until removed by drainage. Drainage water from irrigated land is returned to the streams from which the irrigation water was diverted. Consequently, along streams to which diversions are made, the stream water becomes progressively more concentrated in the down-stream direction. With the increased concentration of dissolved salts in the land, larger quantities of water must be allocated to root zone leaching in order to prevent concentrations harmful to plant growth.

In most irrigated areas much more exact information on the water requirements of various crops is necessary if the most economical use of water is to be realized. The quantity of water required by various crops varies widely under different soil and climatic conditions. Knowledge of the water requirement of different crops under given conditions constitutes a basis for minimizing water costs and maximizing the yield and quality of the crops produced.

General plan: The work is done primarily at field stations supplemented by necessary laboratory experiments. The principal field stations are located on Federal reclamation projects. The facilities of these stations are used cooperatively for investigations by other Divisions of the Bureau of Plant Industry, by the Bureau of Animal Industry and the Bureau of Dairy Industry and by State Experiment Stations. The free use of the land and of irrigation water has been provided by the Bureau of Reclamation and this agency has also contributed some buildings and special aid in land leveling and ditch construction. These field stations are located at Huntley, Montana; Newell, South Dakota; Scottsbluff, Nebraska; Fallon, Nevada; Bard, California; and Hermiston, Oregon. Cooperative investigations are conducted also at a State Experiment Station at Prosser, Washington.

Investigations on salt constituents of irrigation and drainage water involve cooperation with the Bureau of Reclamation, the Geological Survey, and the Office of Indian Affairs, all of the Department of Interior, and corporate irrigation districts. These agencies collect samples of irrigation and drainage waters at appropriate gaging stations where the volume of discharge is regularly measured. These water samples with the discharge data are sent to the laboratory where the water is analyzed and the quantities of the salt constituent conveyed past each station are computed. Thus the annual input and output of dissolved salts (the annual salt balance) of an irrigated district is determined. If, at any district, the salt balances is adverse, i.e., the salt input exceeds the salt output,

then remedial measures in the direction of more copious irrigation and improved drainage facilities are indicated.

Examples of progress and current program: The following examples of recent accomplishments under this appropriation are cited to show progress on one or more aspects of the broader problems confronted. Other aspects of these problems are cited as indicating next logical steps to be taken in the research program.

Sustaining yields under irrigation: Recent results indicate that alfalfa, sweet clover and other leguminous crops may not be effective in soil building except as fed to livestock and the manure returned to the soil, or as green manure crops. It is evident that crop yields cannot long be maintained without the use of farm manure and commercial fertilizer.

The value of farm manure, phosphate fertilizer, and good crop rotation in producing high crop yields is being demonstrated at the Huntley, Montana, field station. In an experiment at this station in which nearly one-half of the land is in alfalfa and in which the land is manured at the rate of 16 tons per acre in eight out of eleven years, the following average acre yields were obtained over a period of 15 years: alfalfa, 6.7 tons; corn, 75.5 bushels; oats, 102.6 bushels; beans, 50.3 bushels; potatoes, 535.5 bushels; sugar beets, 20.57 tons; wheat, (10 year average) 54.1 bushels; and barley, (3 year average) 89 bushels. Yields in 1940 due to the favorable seasonal conditions were in most cases higher than the period average.

Continued investigations over a period of 30 years have shown that increasingly intensive use of irrigated land results in a complex soil condition which, unless overcome, affects crop yields adversely. This soil condition evidently is related to physical and chemical factors, affecting plant nutrition; and to pathological factors, involving not only plant disease organisms but such plant parasites as nematodes.

Quality of irrigation and drainage waters: Numerous salt balance investigations are currently conducted on the Rio Grande in New Mexico and Texas in cooperation with the Geological Survey, Bureau of Reclamation, and the United States Section of the International Boundary Commission, United States and Mexico; on the Colorado River in California and Arizona in cooperation with the Geological Survey and the Bureau of Reclamation; and on the Yakima River in Washington in cooperation with the Office of Indian Affairs. In addition to these projects, a survey has been completed of salinity conditions in irrigated soils contiguous to the Pecos River in Texas and New Mexico as a part of the Pecos River Joint Investigation sponsored by the National Resources Planning Board. The investigation is being continued also on the occurrence of boron in irrigation waters of California, Nevada, Utah, and Arizona. A more intensive study of the boron tolerance and boron requirements of crop plants is in progress at the Rubidoux Laboratory, Riverside, California.

In connection with investigations to determine the minimum essential boron requirements of crop plants, it has now been established that the determination of the boron content of plant material provides a dependable indication of the available boron content of the soil solution. This makes it possible to delimit areas of boron deficiency by collecting and analyzing

respective plant material. Such a survey has veen undertaken using alfalfa, sugar beets, and sunflowers.

Water requirement of crop plants: In 1939 water requirement work previously done by the Division of Irrigation of the former Bureau of Agricultural Engineering was transferred to the Bureau of Plant Industry. In this field of research the following investigations are in progress: (a) the capacity of the root zone reservoir, its need of replacement by irrigation and its need of leaching for salt removal; (b) the rate of use of water by crop plants as influenced by stage of growth, climatic conditions and level of nutrition; (c) factors affecting the drainage of crop land including the ef ect of volume-weight or density of soil on rate of drainage and the adaptation of the Dunmore Electric Hygrometer to soil moisture determinations; (d) the water requirement of cotton in Arizona, including studies of the influence of the time and number of irrigations and the amount of irrigation water on growth and fruiting and on the yield and quality of cotton; (e) water requirement of pears under irrigation with respect to maximum production of fruit of high eating and shipping quality; (f) the relation of moisture and soil aeration to functioning of citrus and avocado trees under irrigation agriculture; (g) effects of irrigation and drainage on strawberry production in humid areas; and (h) effects of irrigation and drainage on truck crop production in humid areas.

Indications are that nearly as good pear production can be secured with less total water if larger quantities are applied at each of a fewer number of applications. Fourteen and one-half inches of water in four irrigations were almost as effective as 17.7 inches in eight irrigations since more of the water penetrated to greater depth and less was lost by evaporation.

In lemon plots receiving three different frequencies of irrigation water, the least frequency resulted in the smallest size of fruit and reduced the amount of fruit available for the fall and early winter picks, with the result that much of the fruit had to be harvested in late winter and spring as yellow, tree-ripe fruit, which is inferior in keeping quality. With more frequent irrigations, the lemons obtained sufficient size to be picked much earlier as "green" or "silver" fruit of good keeping quality and higher market value.

To develop practical methods by which citrus growers may properly time irrigations, comparisons have been made for two years between water losses from a shallow black pan and the soil moisture depletion of citrus trees. The results suggest that ratio values can be obtained for a particular soil type and location that can be used by the grower in determining from observation of the evaporation from the pan approximately when the tree will have so depleted soil moisture as to require another irrigation.

A factor sufficiently accurate for practical use has been determined for estimating the "first wilting point" in a particular soil type on the basis of the observed "moisture equivalent" of the soil.

More complete information on the water requirements of crop plants as produced on different soils and under different climatic influences, is required as a sound basis for equitable distribution and economical use of irrigation water.

(1) NATIONAL ARBORETUM

Appropriation Act, 1942, plus $75, supplemental for within-grade promotions	$54,662
Budget Estimate, 1943	54,892
Change from 1942:	
Additional for within-grade promotions	230

PROJECT STATEMENT

Projects	1941	1942 (estimated)	1943 (estimated)	Increase or decrease
1. National Arboretum:				
(a) Maintenance and operation of Arboretum	$26,700	$27,000	$27,000	
(b) Planning, developing and construction of Arboretum	27,268	27,587	27,587	
2. Net cost of with-in grade promotions	- - -	75	305	+230
Unobligated balance	619	- -	- -	- -
Total appropriation	54,587	54,662	54,892	+230

WORK UNDER THIS APPROPRIATION

Objective: To establish and maintain a National Arboretum for purposes of research and education concerning tree and plant life, in conformity with the authorizing Act (Pub. No. 799 - 69th Congress).

The problem and its significance: The arboretum of approximately 400 acres is being developed as rapidly as possible. Plantings are being made of numerous species of evergreen and deciduous trees, woody shrubs, vines, ferns and herbaceous perennials. It is planned to grow as many species of the various trees and shrubs in this area as it is possible to obtain. Some of these will be secured through exchange of material with other arboretums in this and other countries. Through our Division of Plant Exploration and Introduction many rare plants introduced from various parts of the world will be made available to the arboretum.

Arrangements will be made to exchange and test plant materials with other arboretums, universities and research institutions as this arboretum develops. New plants introduced from abroad or developed by breeding will receive thorough testing by these cooperating agencies throughout the country. Those plants finally approved for introduction will be propagated and introduced through the regular channels of trade.

The Science of genetics, which has done so much to improve some of the common crop plants, such as wheat and corn, is being applied to the breeding of trees and shrubs. With the arboretum's great storehouse of materials from all corners of the world, breeders of trees, shrubs and flowers will have an opportunity to cross native species with those from foreign lands for the development of improved strains adapted for special purposes such as for city parks, forests, boulevards, streets, etc. It is expected to make the facilities of the arboretum available to scientists all over the world, and cooperation is contemplated with foresters, botanists, horticulturists and other scientists in the improvement of trees, shrubs and other plants. The arboretum thus becomes an educational institution which at the same time will provide an abundance of growing plant material for scientific purposes. In order to be most useful for purposes of research and education, the arboretum is being planned and developed with a view to (a) taking the fullest possible advantage of all environmental factors at the site selected, such a soil type, slope, exposure and drainage; (b) the grouping in the most suitable locations of all the adapted plants of many genera or species; (c) making them available for general observation and detailed study, and (d) preserving for reference, identification and classification, herbarium specimens of all plant materials likely to be of value in this country.

General plan: The National Arboretum is located in the District of Columbia, bounded approximately by M and R Streets, N. E., Blandensburg Road, and the Anacostia River. An advisory council, appointed by the Secretary of Agriculture in accordance with the Act of March 4, 1927 (20 U. S. C. 191-194), assists in planning the development of the Arboretum. The work at the Arboretum is supervised by a director, under the general direction of the Chief of Bureau.

Plant collection generally are established in nurseries at the Arboretum prior to being placed in permanent plantings. Plant materials are obtained by purchase, gift, and by transfer from our Division of Plant Exploration and Introduction, a source of exotic plants from foreign countries.

Examples of progress and current program: During the past season about 1,300 evergreen trees, including such things as Canada hemlock, Carolina hemlock, Norway spruce, white pine, Chinese juniper, etc. have been planted. In addition 270 trees of the Pea family have been planted, including such things as: Acacia, redbud, indigo, golden chain, and various hybrid and horticultural forms of black locust.

At present 28 different species of maples, including some red-silver maple hybrids, are being planted. These hybrids combine the color of the red species with the vigor of the silver maple.

On hand in the nurseries at the National Arboretum is a large number of evergreen and deciduous trees and shrubs, many of which will be planted through this fall, winter and spring. This group includes 6,550 evergreen trees, 2,207 deciduous trees, 30,590 evergreen shrubs and 2,306 deciduous shrubs. The transplanting, cultivation

and general care of this material will of course require considerable field labor and close supervision. To provide for the water requirements of nursery plantings, the water system was extended; and, as a means of expediting propagation work, and additional pit greenhouse was constructed.

At the Bell Station of the Bureau 25,065 plants, covering such species as rhododendrons, azaleas, flowering apples, conifers and hollies, have been grown, and many of these will be placed in the arboretum during the coming year. One thousand, eight hundred and thirty-two plants, covering about 360 species, have been purchased recently, and these will be planted during the winter and early spring. These include horse-chestnut, buckeye, alder, shadblow, birch, hornbeam, dogwood, elaeagnus, Euonymus, hydrangeas, junipers, larch, tree peonies, poplars, buckthorn, mountain ash, tamarix, viburnums, hollies, magnolias, maples, rhododendrons and azaleas.

Soil studies were made of various areas to determine their suitability for different group plantings. About 200 acres intended for permanent group plantings were conditioned by the growing of green manure crops. One area of 60 acres, formerly under green manure cropping, was sown to grass (meadow type) as a foundation for Arboretum groupings.

Work in the physical development of the National Arboretum, accomplished through assistance rendered by a CCC camp, included grading, sodding, and improvement of roadsides, with over 4800 square yards of sod laid; construction of about 1000 feet of new roadway, and preliminary survey of 1000 feet of additional roadway; construction of cement and rock facing for 800 feet along Hickey Run to prevent flooding; and construction of a garage and a combination boiler house. Necessary materials and equipment used in the foregoing improvement work were supplied by the Arboretum.

Basic studies were continued on the general plan of development of the Arboretum, more particularly with respect to general layout, sites for permanent plantings of various plant groups as they become available, and the essential steps to be taken in order to insure the successful establishment and maintenance of such plantings.

(m) PLANT EXPLORATION, INTRODUCTION, AND SURVEYS

Appropriation Act, 1942, plus $3650, supplemental for within-grade promotions	$354,597
Budget Estimate, 1943	322,210
Change from 1942:	
Reduction in working funds	-35,947
Additional for within-grade promotions	+ 3,560
Net decrease	-32,387

PROJECT STATEMENT

Projects	1941	1942 (estimated)	1943 (estimated)	Increase or decrease
1. Plant exploration and introduction	$180,605	$182,154	$165,554	-$16,600(1)
2. Botanical investigations	76,602	77,453	62,753	- 9,700(2)
				- 5,000(3)
3. Rubber production, breeding, and disease investigation	42,079	42,379	32,732	- 9,647(4)
4. Nematology investigations	48,868	48,961	53,961	+ 5,000(3)
5. Net cost of within-grade promotions	- -	3,650	7,210	+ 3,560
Unobligated balance	2,993	- -	- -	- -
Total appropriation	350,947	354,597	322,210	- 32,387

DECREASE

The decrease of $35,947 in working funds under this item for 1943 consists of:

(1) A decrease of $16,600 under Project 1, Plant exploration and introduction. This contemplates discontinuance of explorations to collect foreign plants of potential value to American agriculture, and curtailment in the introduction of plant material through exchange and purchase. The number of plant introduction items propagated and distributed to cooperators in the "experimenters' service" will be curtailed. Curtailment will be made in testing work on the large plant introduction collections which have been made in recent years.

(2) A decrease of $9700 under Project 2, Botanical investigations. This contemplates a reduction in the plant identification service rendered to other Federal agencies, a material curtailment in the development of the economic plant herbarium collection, and in botanical field studies.

(3) A decrease of $5,000 under Project 2, Botanical investigations, involving a shift of funds in this amount to Project 4, Nematology investigations. This contemplates additional work to determine practical control methods for plant diseases caused by or related to nematodes, which cause losses each year amounting to several millions of dollars. The root-knot nematode is particularly serious, attacking cotton, tobacco, young tung trees, sweet and Irish potatoes, tomatoes, nursery stock, wheat, fruit trees and literally hundreds of other plants. The transfer would be effected by discontinuing, under Project 2, Botanical investigations, the work of a P-3 employee in surveying and studying cotton diseases, in cooperation with the principal cotton States, and by reducing general expenses in connection with the plant disease survey conducted with collaborators throughout the country to determine the extent and severity of plant diseases.

(4) A decrease of $9,647 under Project 3, Rubber production, breeding, and disease investigations. This contemplates curtailment of adaptation studies on the Brazilian rubber tree, Hevea brasiliensis, at Coconut Grove, Florida, and of planting and selection work on rubber-producing strains of goldenrod at Savannah, Georgia.

Personnel curtailments contemplated under the decrease of $35,947 in working funds under this appropriation are shown in the following tabulation, the first column of which indicates personnel to be released and the second column anticipated vacancies that will not be filled:

Departmental:	1 P-1 Jr. librarian	1 P-3 Assoc. botanist
	1 SP-4 Assistant scientific aid	1 CAF-3 Asst. clerk-Stenographer
	1 SP-3 Jr. Scientific aid	
	1 SP-2 Under scientific helper	
Field:	1 P-2 Asst. geneticist	2 SP-4 Asst. scientific
	1 P-1 Jr. botanist	1 CAF-3 Asst. clk.
	1 CAF-6 Prin. Translator	

The estimated distribution of the reduction by States is as follows:

California	$ 2,700
District of Columbia	24,167 (a)
Florida	4,860
Georgia	4,220
	35,947

(a) Includes funds allocated as needed at field stations for supplies, equipment, repairs, etc.

WORK UNDER THIS APPROPRIATION

General: The work under this appropriation, as organized under authority provided in the 1942 Appropriation Act, embraces the work formerly done under three subappropriations, "Plant Exploration and Introduction", "Mycology and Disease Survey", and "Nematology". Although differing in detail, these three lines of work serve a common purpose in the Bureau of Plant Industry--they provide basic materials and technical skills and services essential to the effective prosecution of the plant research

conducted under other subappropriation items. This fact becomes apparent in the following statement.

Objective: To fortify crop production, improvement, and disease control research in the United States by (a) supplying through exploration, exchange, gift, or purchase plant materials of promise in this country either as new crops or as breeding stock for improving old crops; (b) providing specific information on the native habitats of introduced plant materials as a guide to their best use in this country: (c) collecting and preserving specimens of all crop plants and plant disease organisms; (d) furnishing authoritative service in the identification and classification of plants, plant diseases, and nematodes; (e) determining the incidence, identity, and current status of plant diseases throughout the United States; and (f) studying the reaction of various plants to nematode attack, the natural enemies of nematodes and the role of nematodes in soil-life as related to crop production. Additional objectives are (g) to improve mushroom culture and (h) to determine the rubber-bearing value of various native and introduced plants.

The problem and its significance: More than half of the economic crops of the United States have been introduced from other parts of the world. Possibilities are still great for finding in various places--even among wild native plants of this country--plants that will add as much to American agriculture as any past introduction. Introduced plant material may prove readily adaptable to conditions in parts of this country and soon thereafter become established as a farm crop; it may be of special value in connection with soil conservation or it may be valuable chiefly as breeding material for the improvement of crops already produced here--it may be resistant to some menacing disease, an insect pest, drought, cold or other natural hazard, or it may have a desirable quality of texture or flavor.

An occasional introduction may possess important commercial qualities--it may be a source of a drying oil, an essential oil, tannin, protein, rubber, or an important fiber; or it may be an edible fungus of importance to the mushroom industry. There is always a chance also of its being resistant to nemotodes or in some other way important in connection with methods to control nemotodes.

The search for such plant materials is facilitated by fore knowledge of environmental conditions in various parts of the world and of the conditions under which the desired material is most likely to be found. Likewise, complete information relative to the native habitat of plant material is a splendid indicator of the kind of environment most likely to favor successful culture of the introduced material.

Because introduced material may harbor disease organisms or insects that could seriously affect other crop plants in this country, it is necessary constantly to exercise the most careful vigilance. Once safely in this country, having survived quarantine inspection, possibly fumigation, and other precautionary measures, the introduction must be propagated and increased for use by the plant breeder or other scientists.

In order to make the best possible use of an introduction, it is essential that related species and genera be studied, their susceptibility to various diseases known, and the existence or absence of such diseases or disease organisms in the areas where the introduction is to be used. This calls for the maintenance of extensive herbaria in which are preserved thousands of plant and plant disease specimens, so that accurate identification and classification may be assured.

General plan: Exploration and introduction are planned to meet as far as practicable the needs of crop specialists in this bureau in cooperating State experment stations, , the Soil conservation Service, and other agencies. An inspection service is maintained in Washington, D.C., in cooperation with the Bureau of Entomology and Plant Quarantine. Detention facilities are provided at Glen Dale, Maryland, and testing facilities at various other places in cooperation with Federal and State agencies and a limite number of private agencies. These test areas are sources of material for use by the crop specialists. Economic herbaria of plants and plant disease specimens are maintained in Washington, D.C. Technical services are rendered cooperating agencies in the identification, classification, and use of materials. A plant disease survey is kept current to reflect the situation in various parts of the United States. Nematological studies show the reaction of various plants to nematode attack and the enemies and diseases of nematodes as a basis for control measures.

Examples of progress and current program: The following examples of recent accomplishments under this appropriation are cited to show progress on some aspects of the broader problems confronted. Other aspects of these problems are also cited as indicating the next logical steps to be taken in the research program.

Project 1. Plant Exploration and introduction

Plant exploration and collection: During the fiscal year 1941, were received from an expedition operating in 1940 in India, Afghanistan, and Iran, extensive collections of fruits and vegetables, particularly from Iran. Exchange of plant material has been maintained with foreign botanic gardens and horticultural and agricultural institutions insofar as possible. Between 5,000 and 6,000 items were brought in from all sources and have been supplied to other divisions of the Bureau of Plant Industry, to the Soil Conservation Service, and to State stations. Over 112,000 items have been placed in experimental plantings in this country and over 10,000 sent abroad in exchange.

Field testing of introduced plants: Approximately 1,600 apple, 500 pear, 700 peach and nectarine, 400 apricot, 400 plum and 200 cherry variety introductions are undergoing trial tests at stations in Maryland, California and Georgia, preliminary to the release of these materials to plant specialists in other Federal and State agencies. These tests include: (1) selection of hardy interstocks for apples; (2) selections from a thousand different apple rootstocks practically immune to woolly-aphis and therefore important to the southern and south-central apple growing regions; (3) approximately 100 peach selections undergoing tests to select those which are most

resistant to root nematodes for use as rootstocks in the commercial peach growing regions of the southern part of the United States and (4) walnut selections of excellent quality and apparent hardiness made at the California station which are now under test at one of the northern State experiment stations. In addition, selections for further study have been made from the most promising peaches, apricots, and plums, secured in the semi-wild parts of Europe and Asia.

Studies are also being made at the Florida and California stations on smaller collections of the subtropical and other fruit introductions, such as citrus, avocado, fig, papaya, persimmon, almonds, filberts, pistachio nut, insecticidal and miscellaneous plants of lesser importance to the horicultural industry.

During the past six years, 22,769 plants, representing species and varieties of jujube, bamboo, Oriental persimmon, chestnut, eucalyptus and miscellaneous plant introductions have been propagated at the Bureau stations and supplied to the Soil Conservation Service for use as soil-binding plants. In addition, 1,550 other lots of seeds and plants considered by the Soil Conservation Service as useful in their program, have been located and introduced for them from foreign and domestic sources. In the past four years propagations of 79 varieties of Oriental persimmons 379 pounds of jujube seed have been given to the Tennessee Valley Authority for their work.

Project 2. Botanical investigations

Plant collections and identifications: During the year the economic herbarium was increased by 30,000 accessions, which materially increased its usefulness. More than 40,000 plant specimens were received for identification from the Forest Service, Soil Conservation Service, Fish and Wild Life Service, Park Service, State Experiment Stations, State and other universities, and from other public and private institutions and individuals. A study of tomato species has been completed which brings out relationships suggestive of possibilities for utilizing certain species in crosses for improving the domestic tomato. An example of such use is the cross between the common tomato, Lycopersicum esculantum, and the wild currant tomato, Lycopersicum pimpinelliformi, from which has been derived the new highly wilt-resistant variety Pan America. Similar studies of onion (Allium) species have brought to light various wild species which offer possibilities for use in the breeding program. Studies of other groups of species related to cultivated plants are badly needed, and some are under way.

Valuable fungus herbarium: The fungus herbarium has now reached a total of more than 423,000 specimens, one of the best in the Western Hemisphere. During the year 14,340 additions were made. This herbarium is widely used for reference and identification by workers on plant diseases in the Department and in State and other institutions. Identifications and the preparation of host and fungous records are an important service to plant disease workers. During the year 34,511 such records were made, together with the listing of some 3,570 new species cards. The extensive fungus collections made by the Rubber survey parties in Central and South America were identified and added to the herbarium. A check list was

prepared for fungi from Peru, and one of fungi attacking insects. The plant disease survey was continued through the cooperation of 200 official collaborators scattered throughout the country, all serving without pay. The Plant Disease Reporter giving the information on plant diseases summarized from the reports of these collaborators, now on its 25th volume, is distributed to about 1,000 individuals working in the plant disease field. A check list of the diseases of economic plants in the United States is being prepared. All of these activities are a service to other Departmental agencies and to public and private interests working in the field of plant disease control.

Indoor compost for mushrooms: A method has been developed of fermenting organic composts indoors under controlled conditions that make a satisfactory mushroom compost in less than two weeks, as contrasted with four or five weeks required in outdoor compost heaps. The principle involved in this method also makes possible the preparation of mushroom compost more nearly standard for commercial purposes. It is, therefore, being used by commercial growers. From an experimental standpoint, the indoor method makes possible a more exact comparison of the effect on mushroom production of different substitutes and supplements for horse manure, which is becoming increasingly scarce.

Project 3. Rubber production, breeding, and disease investigations.

Rubber bearing plants: It has been demonstrated that the Para rubber tree, Hevea brasiliensis, can be grown in Florida, although its commercial possibilities are very limited in spite of the high quality of the rubber produced. Since, however, this is one of the disease-free locations known in the entire world where Hevea can be grown, our plantings in Florida assume great value as a center for absolutely disease-free materials to be used as sources of supply for new plantations in Tropical America. The continued production of these disease-free stocks is needed for projected plantings in Tropic areas.

The investigation of other hardy rubber-producing plants is being continued. There are many plants capable of being grown in the United States that contain traces or small amounts of rubber. Data from the Edison experiments and additional data based upon our own tests are of value in preventing the exploitation of many of these plants which have not been developed to the point where commercial growing is feasible. The work with goldenrod has shown the best species of this plant and the areas where they are adapted. Selections have been obtained, now available for increase if necessary, that will produce 200 to 300 pounds of rubber per acre. Newer selections have been made that promise to bring this to a still higher level. Laboratory studies of extraction methods and on uses for goldenrod rubber are promising. This rubber seems to have value for producing pliofilm-like materials useful for packing perishable foods and similar products. With somewhat better yields and improved methods for handling and extraction, commercial production would seem to be a possibility. Additional work is needed to clear up these points.

Studies on the production of rubber from guayule, a shrub native in Mexico and Southwestern United States, show that the cost of producing rubber from this source is greater than that of growing Hevea rubber in the tropics. These

studies show, however, that the rubber produced from guayule is of satisfactory quality, and that under emergency conditions, with supplies of Hevea rubber cut off, a guayule rubber producing industry, producing rubber at a cost of 20 to 25 cents a pound could be developed in this country. Work with guayule as an emergency source of rubber is important.

Project 4. Nematology investigations

Control of root-knot nematode: The root-knot nematode is increasing in its seriousness as a pest of crop plants. It is known to attack some 1,500 different plant species. Most of the standard field, truck and fruit crops grown in the entire Southern half of the country suffer serious losses from its ravages. It is gradually increasing in the intensity of infestation and spreading into other areas as well. Some control can be developed through rotations, but in most cases this is only a partial remedy, it having been shown, as an example, that the bulb nematode of narcissus may persist for at least 18 months in moist soil without its host plant.

Young tung trees have proven highly susceptible to root-knot and may be killed in the first three years on infested soil, although when past this stage they grow well even on infested soil. Tung nurseries should, therefore, avoid infested land.

Crotalaria spectabilis in a three-year test proved highly resistant to the root-knot nematode, the larvae entering the roots being unable to grow and develop. This is important in developing cover crops and rotations for use in infested soils of the Southeast.

Studies of nematocides show that methyl bromide offers promise as a surface fumigant for root-knot-infested soil. Chloropicrin has given promise for use as a "spot fumigant" for hill application in certain widely spaced plantings, such as melons.

A hot water-formulin treatment (0.5% for four hours at 110-111½°F.) has proven very successful in controlling the bulb nematode in narcissus.

While progress has been made in obtaining information on life history and host range of the various nematodes, and even on some phases of control, an immense amount of work remains to be done, not only on the widely distributed root-knot nematode, but also on the many other forms such as the bulb or stem nematode, the sugar-beet nematode, [illegible] nematode the bud and leaf nematode, the meadow nematode, the bent-grass nematode, the various free living and other nematodes which harbor and transmit plant diseases, and the nematodes which parasitize insects and allied pests.

(n) SOIL AND FERTILIZER INVESTIGATIONS

Appropriation Act, 1942, plus $3,170 supplemental for within-grade promotions	$358,191
Budget Estimate, 1943	306,470
Change from 1942:	
Reduction in working funds	-55,021
Additional for within-grade promotions	+ 3,300
Net decrease	-51,721

PROJECT STATEMENT

Projects	1941	1942 (estimated)	1943 (estimated)	Increase or decrease
1. Soil management and fertilizer investigations	$235,124	$222,706	$190,245	-$32,461 (1)
2. Soil microbiology investigations	61,742	62,315	49,235	- 13,080 (2)
3. Soil chemical and physical investigations	69,247	70,000	60,520	- 9,480 (3)
4. Net cost of within-grade promotions	- -	3,170	6,470	+ 3,300
Unobligated balance	3,908	- -	- -	- -
Total appropriation	370,021	358,191	306,470	- 51,721

DECREASE

The decrease of $55,021 in working funds under this item for 1943 includes the following reductions:

(1) Soil management and fertilizer testing, $32,461. This decrease contemplates discontinuing cooperative fertilizer testing and soil management work at Columbia, South Carolina; curtailing cooperative research on development of organic nitrogen fertilizers, development of superphosphates less readily fixed in unavailable form in soils, methods of producing phosphate fertilizers that do not require the use of sulfuric acid, development of new potash fertilizers, and of more concentrated mixed fertilizers with properties to prevent the lumping or caking that makes even distribution difficult, studies of normal and isotope forms of chemical elements in fertilizers as related to fertilizer efficiency and plant nutrition, and related problems; together with a reduction in clerical and mechanical services.

(2) Soil microbiology investigations, $13,080. This decrease contemplates curtailment in inspection of commercial legume inoculants, in investigations of organisms concerned with decomposition of organic matter and formation of humus in soils, and of nitrogen-fixing micro-organisms in the soil.

(3) Soil chemical and physical investigations, $9,480. This decrease contemplates material curtailment in services rendered to other agencies in analyzing soils; curtailment of investigations on the chemistry of soil organic matter and on the occurrence of fluorine in soils and plants with relation to fertilizer efficiency; and a reduction in clerical services.

Reductions in personnel contemplated under the decrease in this appropriation are shown in the following tabulation, the first column of which indicates personnel to be released, and the second column anticipated vacancies that will not be filled:

2 P-3 Associate chemists	1 P-3 Associate soil technologist
1 P-3 Associate physicist	2 P-2 Assistant chemists
1 P-2 Assistant bacteriologist	1 CU-2 Junior laborer
1 P-2 Assistant soil bacteriologist	
1 P-2 Assistant mycologist	
3 P-1 Junior chemists	
1 Agent	
1 SP-6 Senior mechanic	
1 SP-3 Junior mechanic	
1 SP-3 Scientific aid	
1 CAF-3 Senior stenographer	
1 CAF-2 Junior clerk-stenographer	

The estimated distribution of the decrease by States is Maryland, $46,614 and South Carolina, $8,407

WORK UNDER THIS APPROPRIATION

Objective: To maintain or increase soil productivity and promote the economical production of high-quality crops, through (a) development of new and more efficient fertilizers; (b) determination of the fertilizer requirements of specific crops on different soils; (c) determination of the relationship of soil micro-organisms to soil composition, soil type, and crop production; (d) testing proposals and products designed for introducing particular organisms or groups of organisms into the soil for improving soil productivity or for the control of soil-borne crop diseases; (e) determination of the physical and chemical properties of soils, and their relations to soil fertility, and (f) improvement in soil management practices, including the use of fertilizers, animal manures, lime, green manure crops, crop rotations, and other soil building measures.

The problem and its significance: Productive soils are essential to economy in crop production. Practically all of the land under cultivation and producing crops in the United States requires special cultural practices in order to maintain or restore productivity. These special practices include liming, the turning under of green manure crops, the addition of barnyard manure or mineral fertilizers, or crop rotations that include legumes. In 1940 over 8,300,000 tons of commercial fertilizers alone were used in this country, and other soil amendment practices were generally observed although not always in proportion to fertility requirements.

The development of new and more efficient fertilizers would insure greater economy in crop production, improve the quality of crops produced, extend the use of fertilizer materials and thereby maintain or improve the productivity of soils generally. In order to accomplish this desired end, it is necessary to determine the fertilizer requirements of different crops on different soil types and under different cultural methods. These methods are modified by both the physical and chemical properties of soils, the influence of micro-organisms on soil and crop relationships, and the climatological factors involved.

It is becoming increasingly apparent, also, that on many soils not only the primary elements commonly found in commercial fertilizers, such as nitrogen, phosphorous, and potash should be applied for best plant growth, but also the secondary elements, including calcium, magnesium, manganese, boron, zinc, and copper. Exact information on how to supply these and other necessary elements, in what proportion, under what conditions, and the factors influencing their availability, is of paramount importance if the soils of this country are to be maintained on a level of fertility that will insure the quantity and quality of crops required.

General plan: New fertilizers having superior qualities or adapted to special purposes are developed in the laboratories at the national headquarters at Beltsville, Maryland. From these headquarters other work done under this appropriation is conducted cooperatively with farmers and state experiment stations in various parts of the United States. Laboratory, greenhouse, and field tests are made with different fertilizer on various soil types and with numerous crops, and the results are made available as rapidly as possible through publication or otherwise.

Examples of progress and current program: The following are examples of recent accomplishments under this appropriation. They are cited to show progress on one or more aspects of the broader problems under investigations. Some of the aspects of these problems are given as indicating the next logical steps to be followed in the research program.

Project 1. Soil management and fertilizer investigations

Preparation of metaphosphates: In the search for more concentrated fertilizers cheaper per fertilizer unit to the farmer, work was begun about 1936 on the preparation of potassium metaphosphate. By 1938 the laboratory research work on this metaphosphate was so promising that the Tennessee Valley Authority, in cooperation with the Bureau, undertook pilot plant operation. The T.V.A. had earlier produced calcium metaphosphate and in later years has manufactured several thousand tons for experimental greenhouse and field tests in cooperation with State stations. It was found to be available for plant use. Further basic knowledge was necessary in the chemical systems involving these compounds. A portion of this is being done by the Bureau because of its facilities in optical equipment for determining chemical structure.

During the last year, four compounds falling between the chemical compositions of calcium pyrophosphate and phosphorus pentoxide have been investigated and their melting points determined. This information is necessary for good furnace operation in the production of metaphosphates. Potassium metaphosphate, like calcium metaphosphate, is highly concentrated (containing 100 percent plant food) and because of reduced bagging, freight, etc., offers plant food at reduced costs to the farmer. Additional studies are needed on the chemical nature of these compounds, the possibilities of mixing with other fertilizers, and their reaction to various soils. Commercial production of both is imminent.

Treatment of rock phosphate: It has been suspected for a decade or more that unavailability of phosphorus in rock phosphate to plants is related to the presence of fluorine in the rock. Laboratory investigations on removing fluorine were started in 1933, and in 1936 a basic study of the reactions led to the method of the removal of fluorine by steam at 1400°C. Plant food tests showed that this calcined phosphate ground to pass a 40 mesh sieve is as available to plants as superphosphate. The technology of mass production of this very promising material has not been perfected, and to assist in this program basic studies of the nature of fluorophosphates and calcined phosphate derivatives are in progress.

Recently developed electric and blast furnace methods for treatment of phosphate rock yield large quantities of phosphorus, most of which is burned with air to form phosphoric acid for conversion into various phosphates. Investigations in the laboratory on catalysts have shown that oxidation may be obtained by employing steam from which hydrogen gas may be recovered, and this oxidized phosphorus reacts with phosphate rock to form the highly concentrated calcium metaphosphate. The hydrogen may be utilized for the production of synthetic ammonia. The method is now operated on pilot plant scale by T.V.A. with a view to effecting economics in the production of synthetic ammonia for munition and agricultural purposes and calcium metaphosphate for fertilizer.

Magnesium content of fertilizers: With the increasing incidence of magnesium deficiency in soils, a survey was made in 1938 of the magnesium content of fertilizers. It was shown that with increasing use of high grade fertilizer material, the magnesium content had diminished. Of later years, magnesium has been supplied as magnesium salts obtained from Germany, or as dolomite. The lack of imports from Germany since 1939 has stimulated research in magnesium substitutes, and how to use them in fertilizers. Magnesium oxide derived from sea water and other domestic sources has been found to be available to plants and to dry the fertilizer mix, an important attribute in regions of high humidity as in the South.

Fertilizers in defense activities: Information on fertilizers, accumulated in our fertilizer investigations, has formed the basis for reports and data found necessary to several defense agencies for the formulation of policies relating to supplies, distribution, transportation and use of nitrogen, phosphorus, potassium and related chemicals. Reports have covered such subjects as phosphate and potash resources of United States; phosphate resources and requirements of Germany and occupied territory; similar information for Great Britain; nitrogen supplies and uses in United States; exports and imports of fertilizer materials and effect of war on them; use of fertilizers on various crops; effects of shortage of potash, phosphate and especially nitrogen on crop yields, quality, farmer returns; sulphuric acid supply on superphosphate supply; and effect of transportation facilities on distribution and use of fertilizers. Two men have devoted most of their time assembling data and assisting defense agencies, while four others have prepared reports and consulted frequently with such agencies on fertilizer material problems. In addition, physical and physicochemical problems related directly to defense have been under investigation.

Patented processes: Since 1937, 3 public-service patents have been granted for new methods and improvements related to fertilizer manufacture. No. 2,107,857 covers processes for oxidizing phosphorus, No. 2,143,438 processes for the production of monocalcium chlorophosphate, and No. 2,240,668 processes for the production of chlorine. In addition, 10 other patents are pending.

Nutrient losses in sandy soil: A comparison of the effects of different crops on nutrient losses in sandy soil supported by chemical analysis of soil water leachings and crops grown shows that winter rye was more effective in preventing leaching and nutrient losses than any other crop tested, followed in order by oats, vetch and peas. Winter fallowing was associated with excessive leaching and undesirably great losses of nutrients, particularly nitrogen, calcium and magnesium. The winter legumes are much less effective than winter grain in reducing such losses under conditions at the Sandhill Station. Further work is needed to show whether the nitrogen fixed by winter legumes is sufficient to overbalance the loss of soil nitrogen and minerals which accompanies their cultivation in the sandy soils of the Coastal Plain.

Project 2. Soil microbiology investigations

Legume inoculation: During 1940 approximately 500 representative cultures of inoculants for legumes were tested in greenhouse and field trials of which approximately 12 percent were found substandard. Through publicity of the results farmers are able to restrict purchases to cultures known to be beneficial. As a result of our research work uniform methods of preparing cultures have been adopted by the manufacturers. The percentage of unsatisfactory cultures has been reduced from about 30 percent in 1930 to 12 percent in 1940.

In order to promote the effectiveness of winter legumes in preventing excessive leaching and erosion in the South, work is in progress to develop better inoculants and methods of application for crimson clover, Austrian peas, vetch, etc., in cooperation with farmers, State and Federal agencies.

It has been found that the wetting of legume seeds with water, and the addition of peat cultures of organisms is as effective and far more convenient than older methods of inoculation employing nutrient solutions.

Importance of organic matter in soil: Organic matter improves soil tilth, increases water-holding capacity, and upon decomposition, releases food for micro-organisms and eventually for crop plants. With decreasing supplies of organic matter seriously affecting crop growth on many soils, greater emphasis is being placed on the importance of organic matter in crop production. Work is being undertaken on the physical, chemical, and bacteriological factors concerned in its formation, maintenance, and decomposition. The importance of this field of research is indicated by preliminary work on organic matter in relation to Texas root-rot of cotton. In this work it was found that if the soil bacteria are stimulated in the fall during the weakest period in the life of the fungus, the disease can be greatly reduced. The increase in soil bacteria was brought about by the addition of organic matter or by plowing which hastened decomposition of plant residues. This and other crop problems such as take-all disease of wheat show a direct relationship between organic matter, micro-organisms and crop growth.

Project 3. Soil chemical and physical investigations

Similarity in composition of associated soils: The classification of soils has been developed primarily on the basis of characteristics observable in the field. To determine to what extent field differences are reflected in the chemical and physical nature of the soil as shown by laboratory examinations, investigations have been made of the closely related series, Miami, Crosby, Brookston and Clyde.

These are productive soils of the glaciated areas of Ohio, Indiana, Michigan and Wisconsin. Of this group of soils the Clyde series is less well drained than the others and contains the most organic matter. Laboratory examinations of the soils and their colloids indicate only minor differences except in quality of clay and of organic matter. These examinations show that the association of soils indicated by field surveys have a real foundation in the similarity of composition of the associated members.

Distribution of minor elements: For several years investigations have been conducted to determine the location of soil areas containing appreciable quantities of selenium and the relation of soil selenium to that contained in plants and this in turn to animal feeding. This work in cooperation with Western States has shown selenium to be found predominantly in soils derived from certain geological deposits (Cretaceous shales). Recently completed work has demonstrated the existence of considerable areas of seleniferous soils in the glacial drift of North Dakota and Miocene areas of Idaho and Oregon.

Continuation of this investigation is desirable to determine the reasons for variations in injury which is apparently not related to the quantity of selenium in the soils. Investigations are also in progress on the occurrence and distribution of boron in soils. Boron has been shown to be present in all soils examined though deficiencies in this element exist in many areas and only occasionally in injurious amounts. Deficiency of boron is detrimental to proper crop development and produces many abnormal characteristics, corking of apples, cracking in celery, root-rot in sugar beets, etc.

The universal presence of arsenic has been demonstrated but so far it has not been found present in injurious quantities in virgin soils.

Rapid soil tests: For more than a decade great interest has been shown throughout this country and the world in the development of rapid chemical tests for the testing of soils to determine their state of fertility and the kinds and quantities of fertilizer constituents that should be added to different soils for good crop production. Recently this Department undertook a comparison of various tests of this kind on widely differing soils of known crop productivity. These investigations have shown that laboratory tests alone are usually very disappointing for the purpose indicated, but when properly used they may be valuable aids to an agriculturist with adequate local information. This comparison has shown the possibility of utilizing some new methods developed or improved for a study of the fate of fertilizers added to different soils, the influence of added fertilizer upon the crops of subsequent years, and the movement of the fertility elements to and out of the subsoil.

(o) SOIL SURVEY

Appropriation Act, 1942, plus $2,355 supplemental for within-grade promotions	$277,355
Budget Estimate, 1943	205,430
Change from 1942:	
Reduction in working funds	-75,000
Additional for within-grade promotions	+3,075
Net decrease	-71,925

PROJECT STATEMENT

Projects	1941	1942 (estimated)	1943 (estimated)	Increase or decrease
1. Soil survey:				
(a) Investigations, classification, and mapping of soils in the field	$150,585	$150,750	$75,750	- $75,000(1)
(b) Field inspection of soil surveys and correlation of soil types and series	71,120	71,500	71,500	- -
(c) Adjusting, constructing, and drafting soil maps and charts for reproduction	52,750	52,750	52,750	- -
2. Net cost of within-grade promotions	- -	2,355	5,430	+3,075
Unobligated balance	545	- -	- -	- -
Total appropriation	275,000	277,355	205,430	-71,925

DECREASE

The decrease of $75,000 in working funds under this item for 1943 consists of:

(1) A decrease of $75,000 in investigations, classification and mapping of soils in the field. This decrease contemplates discontinuing in several States, and reducing in all States, the field work of soil survey, cooperative with the State agricultural experiment stations and other agencies, in the classification and mapping of soils as a basis for agricultural adjustment and land use planning, and a proportionate reduction in departmental services from Washington.

The following reductions in personnel are estimated under the decrease:

Departmental:

1 P-4 Physiologist
1 P-3 Associate soil scientist
1 SP-6 Laboratory mechanic
1 CAF-2 Junior clerk

Field:	3	P-3 Associate soil scientists
	13	P-2 Assistant soil surveyors
	1	P-2 Assistant soil technologist
	1	P-1 Junior soil surveyor

The reduction contemplates complete or essential stoppage of cooperative soil surveys in Arizona, Arkansas, Georgia, Kentucky, Missouri, Montana, New Hampshire, Oklahoma, Pennsylvania, Oregon, South Carolina, and Utah; and a reduction of cooperative work in Alabama, California, Colorado, Florida, Idaho, Indiana, Iowa, Maine, Michigan, Minnesota, Mississippi, Nebraska, New York, North Carolina, Ohio, Tennessee, Texas, Virginia, Washington, and Wisconsin.

WORK UNDER THIS APPROPRIATION

Objective: To classify and map the soils of the United States in order to provide farmers, farm associations, and public agencies accurate, standard soil maps necessary for planning cropping systems and other farm operations, and for the orderly development of farm programs designed to make best use of rural lands with the best available knowledge. This involves the investigation of the character and origin of soils, their classification in a national system, the indication of their extent and distribution upon maps, and the explanation of their capabilities for adapted crops, grasses, and trees, and their stability, under alternative systems of farm management. The mapping of soil types and their correlation with the results of soil and plant research conducted by the Bureau of Plant Industry and cooperating State agricultural experiment stations are the final steps in making this research applicable to individual farms and fields.

The problem and its significance: The nature of the problem. The experience of farmers and the results of agricultural research must be carefully related to soil types so that individual farmers may apply this useful information to the particular soils on their own farms. There are several thousand soil types in the United States, different from one another in a few or in all of their important characteristics that determine their usefulness for various crops, pastures, or trees and their response to cultural practices.

Methods of soil management that lead to high production and soil conservation on one soil type may be less useful, or even ruinous, on another. For example, some are benefited by terracing, others are not; some are acid and respond to liming, others do not; some in dry regions can be irrigated successfully, others can not be; some are very susceptible to blowing or washing, others are not. The adaptability of crops, and even varieties of crops, the need of fertilizers to produce good yields and crops of high quality, especially from the point of view of nutrition, and the effectiveness of the various tillage methods are all different on different soil types.

The main problem of the Soil Survey is to maintain a system of classification, construct maps of soil types, and develop descriptions and ratings of soil types in order that these differences may be understood clearly and definitely as they apply to individual fields and farms. To be effective, the system of classification must be carefully coordinated on a national basis so that similar soil types are everywhere given the same names and definitions. Standards of soil nomenclature, definition, and classification are essential to the success of the research.

The extent of the problem. The land surface of the United States comprises about 3,000,000 square miles. The area surveyed and the best available estimates of soil survey needs, as of July 1, 1941, are given below. These figures may not be entirely exact although they represent revision of careful estimates made in cooperation with the States in 1938--39. In addition detailed surveys are essentially completed for Puerto Rico and Hawaii.

	Square Miles
1. Areas having satisfactory soil maps now, including about 225,000 square miles of relatively old surveys that may require revision in light of our present knowledge	915,000
2. Areas needing detailed soil survey now	920,000
3. Areas needing detailed-reconnaissance soil surveys. (these include those having scattered soils suitable for farming along with others not suitable.)	620,000
4. Areas needing reconnaissance surveys. (Much of this includes rough mountainous land, range land, and forest land, non-arable, and needing only general surveys.)	520,000

Like all research, costs vary with several factors, but three are especially important: (1) the amount of State cooperation, (2) the more exact requirements of the present maps, because of their wide use for detailed farm planning, and (3) the availability of base maps, including air photographs, from other agencies.

Significance. Accurate soil maps have proved highly beneficial and are extensively used as factual guides in the agricultural programs of State agencies, the Department of Agriculture, including the Farm Credit Administration, the Tennessee Valley Authority, and other agencies. Farmers and prospective farmers use these maps in order to make use of the results of agricultural research as applied to their own land. Of great present significance is the State and County planning program sponsored by the Department of Agriculture and the Land Grant Colleges. Local county committees of farmers and representatives of Federal and State agencies concerned with land-use planning, are developing long-time plans for agricultural adjustment and conservation. Repeatedly those committees are finding their work hampered and unsatisfactory where accurate soil maps are not available.

General plan: The Soil Survey is conducted cooperatively with the appropriate State agencies, especially the State agricultural experiment stations. At least some work has been done in every State and Territory, but more has been done in those States making large financial contributions toward the work. Active research is under way now, for at least a part of the year, in 30 to 35 States.

Scientists of the Bureau cooperate with other public agencies, including the Bureau of Agricultural Economics, the Farm Credit Administration, the Soil Conservation Service, the Farm Security Administration, the Tennessee Valley Authority, the Forest Service, the Bureau of Reclamation, and the Bureau of Indian Affairs in developing agricultural and land programs where a knowledge of soil and the interpretation of soil maps and other soil research is necessary.

Men are assigned to survey counties in cooperation with men assigned by the experiment stations. At the present time it costs about $40.00 per square mile for detailed soil surveys, including the preparation of soil description, productivity ratings, and the necessary map drafting, of which the States are contributing about one-half, or a little more, in the form of services of field assistants and scientists. This means a federal cost of about $20.00 to $25.00 for each square mile of detailed survey.

To be effective, the Soil Survey work must be coordinated on a national basis so that similar soils are everywhere given the same names and descriptions in all States. At the same time, the State scientists bring their detailed local experience to bear on the problem. This cooperative basis makes it possible to have the benefits of both local and national experience and to develop a common nomenclature that fits local conditions.

Most surveys have been conducted on the basis of county units. There are a few exceptions, especially in the far West, where only small portions of some counties contain arable land. In the immediate future more work may be expected to be undertaken on larger or smaller areas determined by the urgency of other Federal programs.

The order in which counties or areas are taken up for survey is determined cooperatively with the State and Federal officials in accordance with relative urgency of land-use problems and the imminence of programs based upon soil maps. Under present conditions, only a small fraction of the surveys considered essential by cooperating officials and agricultural planning experts can be undertaken.

Examples of progress and current program: During the fiscal year ending June 30, 1941, soil surveys of 21 areas, mostly counties, were released by the Government Printer, as follows:

Alabama:	Sumter County	Montana:	Middle Yellowstone Valley area
Arizona:	Casa Grande area		
	Yuma Desert area		
California:	Visalia area	Nebraska:	Cass County
Georgia:	Hall County	New York:	Ulster County
Indiana:	Jennings County	North Carolina	Clay County
	Steuben County	Oklahoma:	Pontotoc County
Iowa:	Audubon County		Washita County
	Jackson County	Texas:	Kaufman County
Michigan:	Ingham County		Zavala County
Minnesota:	Pine County	Virginia	Isle of Wight County
		Wyoming:	Uinta County

On July 1, 1941, 31 soil survey reports were in the hands of the Government Printer, exclusive of reprints, as follows:

California:	Pixley area	North Carolina:	Madison County
	Sacramento-San Joaquin Delta area	North Dakota:	Billings County
			Mckenzie County
	Santa Cruz area	Ohio:	Lucas County
	Wasco area	Oklahoma:	Choctaw County
Georgia:	Catoosa County		Tulsa County
	Dade County	Puerto Rico:	Entire Island
Idaho:	Blackfoot-Aberdeen area	Rhode Island	Newport and Bristol Counties
Indiana:	Knox County	South Carolina:	Pickens County
	LaPorte County		Sumter County
Iowa:	Story County	Tennessee:	Jefferson County
Michigan:	Clinton County		Roane County
Minnesota:	Roseau County	Texas	Dimmit County
New Hampshire	Coos County		Maverick County
New York:	Albany and Schenectady Counties	Utah & Arizona:	Virgin River Valley area
	Seneca County	West Virginia:	Greenbrier County

Field mapping in various areas throughout the country amounting to 13,940 square miles of detailed soil survey and 757 square miles of reconnaissance (equivalent to 20 to 24 areas) was completed in cooperation with the States. Progress during 1942 is continuing at about the same rate.

(p) SUGAR-PLANT INVESTIGATIONS

Appropriation Act, 1942, plus $1695 supplemental for within-grade promotions	$368,970
Budget Estimate, 1943	333,950
Change from 1942:	
Reduction in working funds	-37,275
Additional for within-grade promotions	+2,255
Net decrease	-35,020

PROJECT STATEMENT

Projects	1941	1942 (estimated)	1943 (estimated)	Increase or decrease
1. Sugar beet investigations:				
(a) Sugar-beet leaf-spot and root-rot control investigations	$33,274	$33,462	$30,557	-$2,905
(b) Sugar-beet curly-top control investigations, including breeding and other means	89,146	89,445	77,645	-11,800
(c) Sugar-beet production and breeding investigations	69,433	70,137	65,037	- 5,100
(d) Sugar-beet soil-fertility investigations	9,768	10,175	9,355	- 820
Total, Sugar beet investigations	201,621	203,219	182,594	-20,625(1)
2. Sugarcane investigations:				
(a) Sugarcane cultural investigations	28,032	29,035	26,790	- 2,245
(b) Sugarcane disease investigations	36,464	36,667	33,667	- 3,000
(c) Sugarcane breeding investigations	45,240	49,118	44,118	- 5,000
(d) Sugarcane deterioration in storage, Investigations of	7,138	7,136	6,531	- 605
(e) Sugarcane soil-fertility investigations	12,056	12,100	11,300	- 800
Total, Sugarcane investigations	128,930	134,056	122,406	-11,650(2)
3. Sugar sorghum investigations	- -	30,000	25,000	- 5,000(3)
4. Net cost of within-grade promotions	- -	1,695	3,950	+2,255
Unobligated balance	6,724	- -	- -	- -
Total appropriation	337,275	368,970	333,950	-35,020

DECREASE

The decrease of $37,275 in working funds under this item for 1943 consists of the following reductions:

(1) Sugar beet investigations, $20,625, distributed by work projects as indicated in the project statement. This decrease contemplates curtailment in sugar beet research in Idaho and other Western States on control of curly-top, improvement of disease resistance, adaptation of the sugar beet seed industry to new areas, and improvement of cultural and fertilizer practices.

(2) Sugarcane investigations, $11,650, distributed by work projects as indicated in the project statement. This decrease contemplates curtailment of work on problems of sugarcane production, including breeding for resistance to cold and for other desirable characters, developing means of combating chlorotic streak, and cultural and fertilizer practices in the Gulf States.

(3) Sugar sorghum investigations, $5,000. This decrease contemplates curtailment of investigations to develop varieties of sugar sorghum improved in percentage of sugar and yielding capacity per acre, and to determine the suitability of improved varieties for culture in different States.

The decrease in this appropriation contemplates reductions in personnel as follows:

Field:

- 1 P-4 Biochemist
- 1 P-4 Physiologist
- 1 P-2 Assistant agronomist
- 1 Farm laborer
- Seasonal labor

The estimated distribution of the decrease by States is as follows:

District of Columbia	$7,255
California	4,250
Colorado	4,950
Florida	1,765
Georgia	730
Idaho	6,100
Louisiana	5,850
Maryland (Beltsville)	350
Minnesota	500
Mississippi	3,000
Nebraska	375
New Mexico	500
Ohio	500
Oregon	350
Canal Zone	800
	37,275

WORK UNDER THIS APPROPRIATION

Objective: To secure and maintain stable production of sugar crops in the United States and dependencies (1) by breeding, selecting, or introducing superior varieties to safeguard sugar crops against losses resulting from disease or other controllable hazards; (2) by improved cultural practices for obtaining better stands, more efficient production per land unit, and improved quality of product; and (3) by insuring adequate domestic supplies of superior seed.

The problem and its significance: The sugar crops of the United States represent an investment in farm land, farm equipment, irrigation systems, factories, factory equipment, transportation, and power facilities directly concerned in sugar production of nearly three-quarters of a billion dollars. Investments in subsidiary industries furnishing supplies and services and utilizing by-products would increase the total capital investment to a billion dollars.

Sugar beets grown for sugar occupy nearly 1,000,000 acres of choice land in 23 States. Nearly 9,000 additional acres in 8 western states, and experimental plantings in other states are used in intensive sugar-beet seed production enterprises. In the Southern States, 260,000 acres are utilized for sugar production from sugarcane, more than 100,000 acres for sirup production and about 20,000 acres for production of seed cane. Normally, 300,000 acres of sugarcane are grown in Puerto Rico. Sugar sorgo for sirup production now occupies about 200,000 acres in this country.

Low acre-yields and inferior quality of both sugar beets and sugarcane result from disease attack, from unfavorable weather conditions, from improper methods of culture, and lack of adaptation of varieties to soil and climatic conditions. Production costs with sugar crops are relatively high. Therefore, unfavorable seasonal or disease conditions may make the crop in one district or another marginal or unprofitable. In other words, if domestic production of sugar crops is to survive, ways and means must be found whereby these crops, which are subject to the effects from chronic depressions of the sugar price because of world surpluses of sugar, can achieve greater economies in production per unit of cultivated area. Such discoveries are necessary if these crops are to continue as integral parts of our agricultural system, ready and available in time of crisis.

General plan: The work is organized under three headings covering investigations on (a) sugar-beets, (b) sugarcane and (c) sugar sorghums. Sugar beet investigations, in large part conducted in cooperation with State agricultural experiment stations, are carried on at strategically-located field stations near centers of sugar-beet production: East Lansing, Michigan; Wooster and Holgate, Ohio; St. Paul, Minnesota; Scottsbluff, Nebraska; Fort Collins,

Colorado; State College, New Mexico; Salt Lake City, Utah; Twin Falls, Idaho; Davis and Riverside, California; and Corvallis, Oregon. Intensive breeding and genetic investigations, previously at Arlington Farm, will be conducted at Beltsville, Maryland.

Sugarcane Investigations are conducted at field stations at Canal Point, Florida; Houma, Louisiana; Cairo, Georgia; Meridian, Mississippi; Summit, Panama Canal Zone; and Beltsville, Maryland.

Sugar sorghum investigations are conducted at field stations in the Southern States, with additional studies, chiefly agronomic, carried on in Iowa and other States.

Examples of progress and current program: The following examples of recent accomplishments under this appropriation are cited to show progress on one or more aspects of the broader problems confronted. Other aspects of these problems are cited as indicating next logical steps to be taken in the research program.

Project 1. Sugar beet investigations

Sugar beet seed production: The world situation has placed the United States on its own resources as to the varieties it must grow, and for supplies of seed of these varieties. Fortunately, as a result of work under this appropriation, adapted American varieties were at hand when the emergency arose, and the methods for efficient seed production had been discovered. Not only have domestic requirements been met, but the United States has been able to supply seed to other democracies.

The outbreak of the European war brought immediate demand for sugar-beet seed and, almost overnight, seed acreage had to be expanded into new and untried districts, chiefly in the Pacific Northwest. As was to be expected, the new crop encountered new and threatening difficulties. Oregon seed fields showed a black blighting of the seed stalks. Research found the cause--deficiency of boron in the soils. Similarly, yellowing and poor growth was shown to be due to inadequate supply of sulphur in the soil in certain districts. With causes known, the deficiencies of boron or of sulphur could immediately be remedied and the threatened crops saved. Other problems such as attacks by downy mildew and Ramularia leaf spot remain for solution. These current problems in seed production show the need for reexamination of potential beet seed-growing areas to find new districts into which the enterprise can expand to meet the increased demands brought by the war, or to avoid the wide fluctuations in yields occurring in certain older districts. Additional investigation is needed also to permit discriminating allocation of varieties to the proper districts.

Disease resistant sugar beets: The sugar beet industry in western United States uses almost exclusively the varieties developed and introduced under this appropriation. The curly-top-resistant varieties, especially the newer releases U. S. 33, U. S. 12, and U. S. 22, are largely removing the threat of crop failure because of curly-top. By introduction of

U. S. 15, a curly-top-resistant variety which does not go to seed the first year when used in winter plantings, the great Imperial Valley, unused areas in the San Joaquin and other valleys in California have been opened to sugar beet culture. The curly-top-resistant varieties now available and the improvement which has been made in removing undesirable characteristics, such as tendency to go to seed in the first year of growth, represent definite progress toward providing sorts well adapted to western conditions. However, still greater improvement both in disease resistance and in adaptation must be realized before the heavy losses to growers are adequately removed. The outlook for such advance with continued breeding research is promising.

To meet the menace of leaf spot in the more eastern districts, U. S. 200 X 215, a high yielding, leaf-spot-resistant hybrid, has been introduced. It came into widespread use in 1940 with highly gratifying results and will be used still more extensively in 1941 and 1942. This variety utilizes hybrid vigor, so well known in connection with corn hybrids, to obtain more productivity in sugar beets. In the emergency situation, it has proved more than a stop gap in that it has been superior to the European brands which it replaced. It is still necessary to obtain greater resistance if the periodic heavy losses from leaf spot are to be minimized. Many new varieties now under test give evidence of increased resistance to leaf spot and, when introduced, may further assist in meeting the leaf-spot problem.

Project 2. Sugarcane investigations

Breeding superior sugarcane: Although no sugarcane varieties were released to growers during the fiscal year 1941, three or four varieties have reached a stage of testing, with evidences of superiority, that warrants release next year if they maintain present performance. These varieties are superior in one or more of the desired characteristics, such as resistance to mosaic and chlorotic streak, tolerance of cold and resistance to inversion of sugar after harvesting. Corresponding advances have been made in development of better technique in field operations to promote early and vigorous growth through hot water treatments of seed cane and by other devices.

Breeding now in progress stresses cold resistance as a new and desirable characteristic for sugarcane varieties to reduce losses imposed by untimely cold weather during harvest. Disease hazards continue to bring new disease-control and breeding problems, as evidenced by the recent introduction of a new disease, chlorotic streak, and its rapid spread throughout the cane-growing area, and by the occurrence from time to time of new specialized strains of organisms and viruses causing disease. Development of new varieties improved in tolerance to cold and in disease resistance, and which possess other desirable characteristics, as well as the development of more efficient methods of sugarcane culture are essential to maintenance of farm production on a profitable level.

Project 3. Sugar sorghum investigations

Sorghums for Sugar and Sirup: This work was begun on July 1, 1941, funds having been made available for the purpose in the Agricultural Appropriation Act for the fiscal year 1942. The long-view objectives of the work comprise the development, by breeding, of new varieties improved in sugar and sirup-yielding qualities and in tonnage yields per acre, and otherwise suitable for profitable culture for production of sugar, or of sirup. Failure of numerous attempts to produce sugar commercially from sorghum shows conclusively that the commonly grown varieties are not adapted to profitable production of sugar, whereas results of limited investigations carried on incident to other work have indicated promising prospects for eventually developing new varieties of sorgo, and also sugarcane X sorgo hybrids, possessing characteristics meeting the requirements essential for profitable culture for sugar production. When such varieties are obtained, it will be possible to extend the period of profitable employment of farm labor, tending to balance the seasonal labor requirements on one hundred thousand or more farms, and of transport and factory labor. Another advantage which would accrue is the extension of the period of profitable utilization of sugarcane mills and beet sugar factories in the United States where processing equipment valued at two hundred million dollars is used.

The project, which will be carried on at suitable field locations, comprises a comprehensive program of breeding correlated with an extensive program of testing and evaluating new seedlings, results of which are essential for determining progress in securing combinations of desirable characteristics in seedlings and for eventual selection of varieties suitable for commercial culture. Because of the limited breeding stock now available, and of the need of securing more suitable breeding stock from world-wide sources, it is anticipated that varieties suitable for profitable commercial culture are not likely to be immediately obtained but must await the outcome of breeding and selection research.

(q) TOBACCO INVESTIGATIONS

Appropriation Act, 1942, plus $900 supplemental for within-grade promotions	$141,444
Budget Estimate, 1943	126,950
Change from 1942:	
Reduction in working funds	-15,544
Additional for within-grade promotions	+1,050
Net decrease	-14,494

PROJECT STATEMENT

Projects	1941	1942 (estimated)	1943 (estimated)	Increase or Decrease
1. Tobacco investigations:				
(a) Cigar binder and filler production investigations	$5,643	$5,717	$5,717	- -
(b) Flue-cured tobacco production investigations	26,447	26,812	23,812	-$3,000(1)
(c) Burley tobacco production investigations	9,163	9,235	7,935	-1,300(2)
(d) Maryland tobacco production investigations	7,601	7,860	7,860	- -
(e) Dark air-cured tobacco production investigations	2,400	2,400	- -	-2,400(3)
(f) Tobacco disease investigations	50,994	51,402	46,202	-5,200(4)
(g) Breeding and growing high nicotine tobacco for use in insecticides	9,730	10,050	10,050	- -
(h) Tobacco breeding and physiological investigations	26,797	27,068	23,424	-3,644(5)
2. Net cost of within-grade promotions	- -	900	1,950	+1,050
Unobligated balance	1,769	- -	- -	- -
Total appropriation	140,544	141,444	126,950	-14,494

DECREASE

The decrease of $15,544 in working funds under this item for 1943 includes the following reductions:

(1) Flue-cured tobacco production investigations, $3,000. This decrease contemplates the discontinuance of cooperative work on flue-cured tobacco at Rocky Mount, North Carolina, and curtailment in cooperative work at Tifton, Georgia, and Oxford, North Carolina.

(2) Burley tobacco production investigations, $1,300. This decrease contemplates discontinuance of cooperative work at Lakin, West Virginia, and curtailment in cooperative work at Greenville, Tennessee.

(3) Dark air-cured tobacco production investigations, $2,400. This decrease contemplates discontinuance of this project, involving the elimination of cooperative work at Bowling Green, Virginia, and a proportionate curtailment in departmental services.

(4) Tobacco disease investigations, $5,200. This decrease contemplates the discontinuance of cooperative work for the Connecticut Valley area located at Amherst, Massachusetts, and a reduction in tobacco disease investigations at Beltsville, Maryland, and Washington, D. C.

(5) Tobacco breeding and physiological investigations, $3,644. This decrease contemplates a reduction in biochemical studies on tobacco leaf quality located in Washington, D. C.

Personnel curtailments contemplated under the decrease in this appropriation include discontinuing the services of 1 SP-5 scientific aid, 4 agents, and one farm laborer; and non-filling of an anticipated vacancy in a P-3 associate biochemist position.

The estimated distribution of the decrease by States is as follows:

District of Columbia	$4,704
Georgia	200
Maryland	825
Massachusetts	3,675
North Carolina	2,800
Tennessee	400
Virginia	2,040
West Virginia	900
	15,544

WORK UNDER THIS APPROPRIATION

Objective: To increase returns to tobacco growers by reducing losses from disease and other hazards, lowering costs of production, and improving the quality of the crop.

The problem and its significance: The tobacco crop of about 1,400,000,000 pounds, with a farm value of nearly $300,000,000, is grown on 1,600,000 acres distributed mainly through fifteen States. Taxes on manufactured tobacco yield an annual Federal revenue of about $600,000,000.

In order that growers may secure a fair margin of profit from a limited tobacco acreage it is especially important under present market conditions that they produce, at reasonable cost, the maximum possible proportion of high quality leaf especially adapted to domestic manufacturing purposes. The more essential needs and problems are: development of effective and

inexpensive methods of disease control; improvement and standardization of tobacco varieties; improvements in management of plant beds under newly developed conditions; determining the best cropping systems for tobacco; working out the most effective method of fertilization; improving the methods of curing and handling. There is, also, the special problem of growing tobacco for insecticidal purposes.

Diseases reduce the value of the crop each year by 10 to 20 percent. In the South probably 500,000 acres of tobacco are grown on root-knot infested soil, entailing heavy losses; in central North Carolina Granville wilt has reduced by one-half the value of the finest tobacco soils; blue mold has cost the growers several million dollars in additional seed beds planted; in some years epidemics of wildfire are highly destructive; the new, destructive disease, black shank, is spreading in the South; in northern areas, black root-rot seriously injures the crop.

Of the multitude of varieties and strains of tobacco now grown many produce only small percentages of the most desirable grades of leaf. Lack of suitable woods land is forcing growers to place plant beds on old land in the open, resulting in new weed seed, disease and nutritional problems. Leaf quality is greatly affected by even slight differences in physical and chemical properties of the soil and systems of cropping and management must be developed which will provide optimum soil conditions and minimize the hazards of unfavorable weather conditions.

The light soils on which more than half of the tobacco crop is grown require expensive fertilization and, although outstanding improvement in fertilizer practice has been effected in recent years, lack of accurate knowledge as to quantities and proportions of essential plant food elements required for best results is costing growers large sums in impaired value of the crop. In both the air-curing and flue-curing processes, available means for control of temperature and moisture conditions are inadequate. Nicotine, extensively used as insecticide, is at present obtained from tobacco only as a by-product.

General plan: Each distinctive type of tobacco presents special cultural problems because of varying standards of quality and regional difference of soil, climate, disease distribution, etc. Cooperative experiments are carried out with the agricultural experiment stations of the tobacco-growing States of Massachusetts, Connecticut, Pennsylvania, Maryland, North Carolina, South Carolina, Georgia, Tennessee, and Wisconsin. No independent field stations are maintained.

Examples of progress and current program: The following examples of recent accomplishments under this appropriation are cited to show progress on one or more aspects of the broader problems confronted. Other aspects of these problems are cited as indicating next logical steps to be taken in the research program.

Control of tobacco diseases: The work on control of diseases includes studies of the causal organisms; experiments in crop rotation and cultural practices; development of sprays, gas treatments and other chemical control measures; breeding for disease resistance. Rotation studies have shown that corn and

and peanuts help to control the Granville wilt and root knot diseases, respectively. Preliminary tests indicate that a combination of rotation and chemical treatment may give still better results. In experiments with blue mold, certain of the salicylates have appeared superior to the copper oxide now being used. Plant bed soil treatment experiments indicate that it may be possible to develop a satisfactory chemical treatment to take the place of steam; a combination of cyanamid and chloropicrin has given excellent weed and disease control. Progress has been made in the production of new black shank and root rot resistant varieties of high quality, and likewise in the development of types resistant to mosaic disease. A recent collection made in South America has proven highly resistant to Granville wilt. The needs of many areas can only be met with a combination of resistance to several diseases, and work along these lines has been initiated.

Improved cigar types: The new Havana Seed strain developed in recent years in the Connecticut Valley which produces large yeilds of quality leaf on both root rot-infested and disease-free soils, continues to gain in popularity and with further slight improvements in shape of leaf promises to become standard. Similar strains are being developed in Wisconsin. In Pennsylvania a major unsolved problem in improving the quality of cigar filler, as well as increasing the resistance of the crop against the destructive wildfire leaf spot disease, is to find practical means of increasing the availability of the potash of the soil and its absorption by the crop. Since it has been found that soil moisture is an important factor, appropriate moisture-conserving procedures are being sought. Other promising leads also will be followed.

A more aromatic flue-cured type: As a possible substitute for Turkish tobacco which has been imported in large quantities for blending purposes, experiments are under way in developing a new type having the leaf size and other growth characteristics of the present flue-cured varieties, combined with the high aroma of the Turkish leaf. Type 400, a new and improved flue-cured variety, will be extensively grown this year in the Old-Belt flue-cured area. Standardized recommendations for fertilization of flue-cured tobacco have been made available to growers and are being further developed as research on the subject advances. Coal and oil have been used successfully in flue-curing but further investigations are necessary to develop methods and equipment for better distribution and semi-automatic control of temperature and humidity in the barn.

Burley may be injured by liming: Liming the soil has been extensively practiced in Burley areas, especially when legumes are grown in the rotation, but recent preliminary tests indicate that excess calcium tends to lower the quality of Burley. There is also danger of reducing potash availability which is already a serious problem with Burley soils. Profitable returns have been consistently obtained with decidedly heavier fertilization than is now practiced but the most satisfactory fertilizer formulas have not yet been determined.

Maryland tobacco requires much potash: High rates of potash fertilization have increased the market value of Maryland leaf by at least 25 percent. Its

liberal use has been an important factor in preventing destructive outbreaks of the wildfire disease and tends also to prevent injury to quality from drought. Abundant potash produces a large, thin, fine-textured leaf, ideal for cigarette manufacture. More information is required as to the forms of potash which are most effective.

High yields of nicotine: When adequately irrigated at Davis, California, the new rustica type 68 has produced remarkably high yields of nicotine, more than 250 pounds per acre. Further improvement in the rustica varieties by breeding is under way, which should reduce labor costs in growing the crop.

(r) RUBBER INVESTIGATIONS

Second Deficiency Act, 1940 (available for fiscal year 1941 and until expended)	$500,000
Budget Estimate, 1943	- -

PROJECT STATEMENT

Project	1941	1942 (estimated)	1943 (estimated)
Special rubber investigations:			
Surveys and investigations directed toward the development of rubber production in the Western Hemisphere:			
Bureau of Plant Industry	$238,394	$164,677	$36,929
Office of Foreign Agricultural Relations	15,796	24,204	20,000
Total obligations	254,190	188,881	56,929
1941 balance available in 1942	+245,810	-245,810	- -
1942 balance available in 1943	- -	+ 56,929	-56,929
Total appropriation	500,000	- -	- -

WORK UNDER THIS APPROPRIATION

Objective: To develop rubber production in quantity in the Western Hemisphere, through breeding disease-resistant, high-yielding strains of the Para rubber tree, Hevea brasiliensis, determining cultural and harvesting practices, and making available to cooperating countries improved strains and methods, thus providing a source of supply relatively close to the United States and aiding indirectly in the establishment of a more complementary, balanced trade between the United States and Latin America.

The problem and its significance: Approximately 97 percent of the world's rubber production is produced on Far Eastern plantations from the Para rubber tree, Hevea brasiliensis, native to the Amazon jungles but taken to European possessions in the East in 1876. The United States uses over 50 percent of the total world supply of rubber, and 97 percent of the rubber imported of necessity comes from the distant producing areas of the East.

Tropical areas of the Western Hemisphere suitable for the Para rubber tree extend from southern Mexico to northern Brazil and Bolivia. This region comprises portions of fifteen Latin American republics representing a great

variety of soils, climates, and native populations. In order to effect large-scale rubber production in these areas it will be necessary to overcome the disease hazards to which the Para rubber tree is susceptible, principally leaf blight, and to adapt present methods of rubber production or to develop new methods suited to local population and to local conditions in each area.

Extensive survey data are available about those areas which are considered favorable for rubber production. However, such general surveys and accumulated knowledge must be supplemented by actual test plantings to determine more specifically the suitability of each district and the adaptability of the leaf-blight-resistant high-yielding clones now being propagated and distributed to interested planters in the selected districts.

No extensive research on the South American leaf blight has been made to determine the effect of climate, altitude, soil, and biologic factors on the severity of the disease. It is contemplated that by making experimental plantings in cooperation with Latin American countries which contain areas favorable for rubber production, it will be possible to determine the ecological factors which interact to increase or decrease the susceptibility or resistance to this disease of the selected rubber strains, and it is hoped through spraying experiments to control the disease in the nursery. Such widespread experimental plantings will serve also as demonstration centers for the encouragement of the small farmer, or individual family type industry, particularly in the higher labor-cost countries.

Rubber is an important agricultural product which can be encouraged in Latin America with assurance of increasing trade relations and opening up important market outlets for manufactured goods and agricultural products produced in the United States.

General plan: The work done under this appropriation is done principally in Central and South America in cooperation with various countries as arranged through the Office of Foreign Agricultural Relations working with the State Department. Desirable coordination of interests among all agencies interested in rubber development in the Western Hemisphere is also maintained through the Office of Foreign Agricultural Relations. The Bureau of Plant Industry is primarily responsible for the technological work done, including surveys, collection, testing, and propagation of planting material; selection and breeding, disease studies, and cultural methods.

Examples of progress and current program: The following examples of accomplishment under this appropriation are cited to show progress on some aspects of the broader problems confronted. Other aspects of these problems are also cited as indicating the next logical steps to be taken in the research program.

Surveys have been made in 15 Latin American countries, and in cooperation with local governmental agencies, actual rubber plantings have been started in 12 of them. Among the many millions of acres of land suited for cultivation of the Para rubber tree the most favorable districts considering such factors as accessibility, ownership, density of population, labor

costs, and possible financial resources were selected for these initial demonstration plantings. Such plantings vary greatly in character, such as nurseries, budwood multiplication gardens or permanent field plantings, and the number in each country is roughly proportional to the amount of public and private capital thus far attracted to the program. Several millions of seed were distributed in the fall of 1941 by this Government for the establishment of strategically located nurseries to grow seedling stocks for budding with the superior strains in 1942.

An important function of the surveys was to determine the amount and accessibility of wild rubber, mainly Hevea and Castilla, and to locate old plantings of Castilla. Because of the immense areas involved much remains to be done in that feature of the program. In connection with anticipated increased exploitation of the wild rubber, information on improved methods of gathering latex and preparing the rubber as smoked sheet has been extended to cooperating countries. Examples of sheeting machines and other modern equipment for small-scale operations have been supplied to cooperators, with specifications for duplicating the equipment.

Three field stations, mainly supported by this Government, have been established on land and with other facilities furnished by the local Government in each of Costa Rica, Haiti, and Honduras. Specialists have also been assigned for cooperative research at local governmental agricultural stations or institutes in Brazil and Mexico.

The stations in Haiti and Honduras have concentrated on propagation of the available superior strains and distribution to all cooperating governments. Their location in blight-free areas has permitted the planting of gardens for future breeding and seed production, in which the most valuable, but blight-susceptible strains from the East will be crossed with apparently immune wild selections from the Amazon for the development of rubber trees possessing superior yields and special qualities unattainable in the East with material which originated from a single locality in Brazil.

The cooperative projects in Costa Rica and Brazil have concentrated on solution of the leaf-blight problem and the immediate development of additional strains of the tree which combine superior yield with resistance. This work has been greatly facilitated by the public spirited assistance of American companies having established rubber plantations in these countries. Some 400,000 seed from high-yielding Philippine strains were imported and the seedlings tested for resistance during 1940-41, while more than 2,000,000 additional ones were imported in the fall of 1941 from Liberia for this purpose. Extensive collections from the Amazon have been assembled and tested. A small percentage of seedlings from plantation sources are resistant to leaf blight and range high in yield. The few dozen thus far obtained have been propagated as budded strains and distributed to cooperating agencies.

SUPPLEMENTAL FUNDS

The Budget Estimates for the Department of State, under the item "Cooperation with the American Republics", contemplate the transfer of $150,000 from that appropriation to the Secretary of Agriculture for continuation in the fiscal year 1943 of surveys and investigations directed toward the development of rubber production in the Western Hemisphere. A schedule of obligations appears in the printed Budget under the State Department. The item will be considered by the Subcommittee on Appropriations for State, Commerce, Justice, and the Judiciary, as an important part of the program for cooperation with the American Republics being conducted under the general supervision of the Secretary of State.

SUPPLEMENTAL FUNDS
(Complete Bureau Statement)

Direct Allotments

Projects	Allotments, 1941	Estimated allotments, 1942	Estimated allotments, 1943
Special Research Fund:			
Special research projects	$141,300	$108,000	$96,000
Special research laboratories in major agricultural regions	338,800	330,300	330,300
Within-grade promotions - net cost	- -	370	- -
Total, Special Research Fund	480,100	438,670	426,300
Conservation and Use of Agricultural Land Resources: For analysis of fertilizer samples	2,780	3,335	- -
Public Works Administration, Allotment to Agriculture, 1935-1941 (B.P.I.): For investigations of soil salinity problems in the Pecos River area	3,084	- -	- -
Working Fund, Agriculture, B.P.I., (Emergency Management, National Defense Research Committee, War) 1940-1942: For investigations of isotopic separations	5,000	7,400	- -
Working Fund, Agriculture, B.P.I., (Office for Emergency Management, War) 1940-1942: For castor bean production investigations	3,500	- -	- -
Working Fund, Agriculture, B.P.I., (Advance from "12F5836 Commodity Credit Corporation Capital Fund"): For development of methods of properly caring for grain in storage	- -	3,000	- -
Cooperation with the American Republics, Department of State (Transfer to Agriculture) (Rubber Investigations, Bureau of Plant Industry)	- -	- -	150,000
TOTAL, Supplemental funds (direct allotments)	494,464	452,405	576,300

PASSENGER-CARRYING VEHICLES

The authorization for the purchase of passenger-carrying vehicles for the Bureau of Plant Industry contemplates a decrease in number of cars estimated to be purchased from 37 in the fiscal year 1942 to 24 in the fiscal year 1943. The 24 cars to be purchased in the fiscal year 1943 will permit the needed replacement of this number of vehicles, at an estimated net cost of $15,875. No new vehicles other than replacements are estimated for 1943.

The cars to be replaced in the fiscal year 1943 will have been operated an average of four years, with an estimated average mileage of 51,000 on July 1, 1942. All of the replacements will be used at points in the field incident to the conduct and supervision of experimental work.

The work of the Bureau of Plant Industry is largely in the country where public transportation facilities are inadequate, and transportation through the use of automobiles is essential to effective work. Experience has shown that the use of government-owned cars provides necessary transportation at lower cost to the government than payment of mileage for privately-owned vehicles. For the past six years, the cost per mile of cars operated by the Bureau of Plant Industry has been approximately 2.6 cents, including depreciation.